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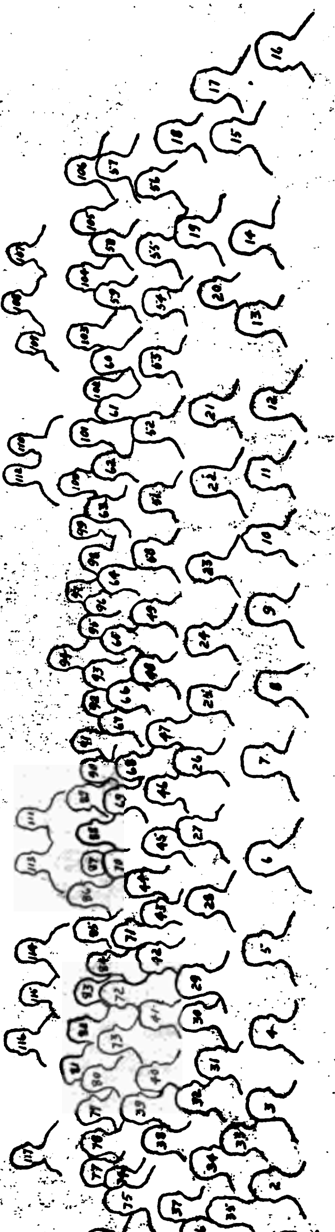

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Society
FOR THE
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PROCEEDINGS
OF THE
TWENTY-EIGHTH ANNUAL MEETING
HELD AT
THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICH.
JUNE 29–JULY 2, 1920

VOLUME XXVIII

PUBLICATION COMMITTEE
ARTHUR F. GREENE, JR. JOHN F. HAYFORD F L. BISHOP

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1919-1920

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A large part of the work of the Society is conducted by committees under the direction of the Committee on Committees and their work for the year 1920–21 is:

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2. Publication Committee: Mortimer E. Cooley, W. O. Wiley, and F. L. Bishop.

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7. Institutional Committee: T. U. Taylor, *Chairman.*

To bring the policies of the Society to the attention of the executives and other teachers in their institutions and to represent the Society at the institutions.

8. Committee on Admission: O. J. Ferguson, *Chairman,* L. L. Thurstone, L. P. Rondinella, and C. E. Magnusson.

Study of the methods of admission to engineering schools including European schools.

9. Committee on Administration: H. S. Evans, *Chairman,* F. P. McKibben, W. G. Raymond, John T. Faig.

10. Committee on Mathematics: L. C. Plant, *Chairman,* E. R. Hedrick, and C. E. Comstock.

Coöperate with the National Committee on Mathematical Requirements, under the auspices of the Mathematical Association of America.

11. Chemistry: Joint Committee on Chemistry: R. M. Bird, *Chairman.*

American Chemical Society: H. P. Talbot, S. W. Parr and R. H. McKee.

Society for the Promotion of Engineering Education: R. M. Bird, J. H. James and J. R. Withrow.

12. Committee on English: C. W. Park, *Chairman,* J. R. Nelson, Sada Harbarger, and J. R. Macarthur.

Continue the study of the present status of the teaching of English to engineers.

13. Committee on Physics, Mechanics and Hydraulics: W. S. Franklin, *Chairman,* G. W. Stewart, G. S. Thompson, O. H. Basquin, C. I. Corp, H. H. Higbie, and C. J. Tilden.

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20. Committee on Standardization of Technical Nomenclature: J. T. Faig, *Chairman,* W. D. Ennis, F. N. Raymond, Chas. Warren Hunt, and S. E. Moss.

21. Committee on R. O. T. C.: P. F. Walker, *Chairman,* C. R. Mann, and Anson Marston.

22. Committee on Intelligence Tests: L. L. Thurstone, *Chairman,* Wm. T. Magruder, Anson Marston, Dugald C. Jackson, and C. R. Dooley.

23. Committee to Coöperate with the American Society of Mechanical Engineers: Ira N. Hollis, *Chairman.*

24. Committee on Railroad Special Apprenticeship: C. Russ Richards, *Chairman,* D. D. Ewing, L. S. Randolph, W. D. Pence, and E. E. King.

Present status of railroad special apprenticeship.

FINAL PROGRAM OF THE 28TH ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICH., JUNE 29 TO JULY 2, 1920.

TUESDAY, JUNE 29.

11:30 A. M.—Meeting of the Council in the Michigan Union.
12:30 P. M.—Luncheon for the Members of the Council at the Michigan Union.

2:00 P. M.—Opening Session.

Address of Welcome by President Harry Burns Hutchins.
Response to the Address of Welcome, Arthur M. Greene, Jr., President of the Society.
Addresses: Coöperation Between Industry and Education.
R. D. Chapin, President, Hudson Motor Car Company.
S. P. Capen, Director, American Council on Education.
Discussion: Opened by John Airey, University of Michigan.
Appointment of Committees on Resolutions and Nominations.
5:00 P. M.—Twilight recital by Professor Earle Moore on the Frieze Memorial Organ in the Hill Auditorium.
8:00 P. M.—Reception in the Assembly Room of the Union.

WEDNESDAY, JUNE 30.

8:30 A. M.—Meeting of the Institutional Delegates.
9:30 A. M.—Second Session.

Conference on Engineering Experiment Stations. Charles S. Howe, Chairman, Special Committee.
Address: "Coöperation of the Engineering Societies With the Engineering Schools." Ira N. Hollis, President, Worcester Polytechnic Institute.
Discussion: Opened by Mortimer E. Cooley, University of Michigan. J. H. Dunlap, The State University of Iowa.

Report of Committee (23) to coöperate with the American Society of Mechanical Engineers. Chairman, C. L. Mees, Rose Polytechnic Institute.

Report of Committee (21) to coöperate with the War Department. Chairman, Charles S. Howe, Case School of Applied Science.

Discussion: Opened by J. F. Parker, University of Michigan. Peter Field, University of Michigan.

11:30 A. M.—Automobiles will be at the Union to take the the guests to the Barton Hills Country Club, where luncheon will be served at 12:15 P. M.

2:30 P. M.—Third Session.

Reports of Committees
- (7) Institutional, A. A. Potter, Chairman.
- (8) Admission, O. V. P. Stout, Chairman.
- (9) Administration, F. P. McKibben, Chairman.
- (10) Mathematics, L. C. Plant, Chairman.

Address: Courses in Engineering Problems, E. C. Kiefer, Iowa State College.

Reports of Committees
- (11-a) Physics, G. W. Stewart, Chairman.
- (11-b) Chemistry, R. M. Bird, Chairman.
- (12) English, C. W. Park, Chairman.
- (13) Mechanics and Hydralics, O. H. Basquin, Chairman.
- (14) Economics, C. C. Williams, Chairman.
- Committee on Degrees, A. E. Kennelly, Chairman.

8:00 P. M.—Annual Round Table at the Michigan Union.

THURSDAY, JULY 1.

7:30 A. M.—Committee Round Table Conference at Breakfast.

9:00 A. M.—Meeting of the Council.

9:30 A. M.—Fourth Session.

Address: "Pay of Engineering Educators." F. H. Newell, University of Illinois.

Address: "Coöperation of Public Utilities." H. B. Shaw, Doherty Company, New York City.

Address: "Relation between Technical Schools and Industry." C. S. Coler, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Address: "Coöperation within the Universities." G. C. Anthony, Tufts College.

Report of Committee (22) Intelligence Tests. L. L. Thurstone, Chairman.

Address: "Correlation of the Army Intelligence Tests with Academic Work of our First Year Students." E. F. Coddington, The Ohio State University.

Address: "Rating System for Faculty at the University of Michigan." J. F. Shepard, University of Michigan.

Discussion: H. H. Higbie, University of Michigan, F. H. Newell, University of Illinois.

Report of Committee on Nominations.

Election of Officers.

2:30 P. M.—Fifth Session.

Address: "Department of Engineering Research, University of Michigan." A. E. White.

Address: "Coöperative System of the Electrical Engineering Department, M. I. T." W. H. Timbie, Massachusetts Institute of Technology.

Reports of Committees (15) Civil Engineering. A. H. Fuller, Chairman.

Address: "Highway and Highway Transport Education." A. H. Blanchard, University of Michigan.

(16) Mechanical Engineering, W. W. Bird, Chairman.

(17) Electrical Engineering, C. F. Harding, Chairman.

(18) Mining Engineering, F. W. Speer, Chairman.

(20) Standardization of Technical Nomenclature, J. T. Faig, Chairman.

Report of Treasurer.

Report of Secretary.

7:00 P. M.—Annual Dinner at the Michigan Union.

Ewing, D. D.
Ewing, D. D., Mrs.
Fairman, J. F.
Felgar, J. H.
Ferguson, O J.
Fermier, E. J.
Fessenden, C. H.
Fessenden, E. A.
Field, Peter
Finch, Frank R.
Finch, Frank R., Mrs.
Fish, F. A.
Foberg, J. A.
Franklin, W. S.
Freeman, E. H.
French, Thos. E.
Fuller, Almon H.
Gardner, Raymond F.
Goddard, R. W.
Goodenough, G. A.
Goodenough, G. A., Mrs.
Gould, Fletcher A.
Goulding, Herbert J.
Gram, Lewis M.
Greene, Arthur M., Jr.
Greene, Arthur M., Jr., Mrs.
Hamilton, E. P.
Harbarger, Sada A., Miss
Hatt, W. K.
Hawley, R. S.
Hayford, J. F.
Higbie, H. H.
Higbie, H. H., Mrs.
Hodgkins, H. L.
Hoad, W. C.
Hoad, W. C., Mrs.
Hollis, Ira N.
Hollis, O. N.
Holman, William F.
Homes, M. Goode
Hood, Geo. J.
Hopkins, Louis A.
Howe, Chas. S.
Hower, Harry S.
Hughes, Hector J.
Hutchins, H. B.
Hutchins, H B., Mrs.
Hoexter, S. J.
James, H. C.
John, Walton C.
Johnson, A. R.
Johnson, Pyke
Johnston, W. W.
Jordan, H. H.
Ketchum, Milo S.
Kinsley, Carl
Kiefer, Earl C.
King, Horace W.
Kolyn, M. D.
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Lay, W. E.
Lee, A. O.
Lendall, H. N.
Leutwiler, O. A.
Leutwiler, O. A., Mrs.
Lindbald, A. F.
Linthicum, Frank H.
Long, John J.
Lovell, A. H.
MacKavanagh, T. J.
Magruder, W. T.
Magnusson, E. E.
Maurer, E. R.
McCaustland, E. J.

McCullough, F. M.
McKenry, Nell, Miss
McMullen, O. E.
McNair, F. W.
Meeker, W. H.
Mees, C. L.
Menefee, F. N.
Merrill, Jos. F.
Mickle, F. A.
Miller, Clyde P.
Moore, Earl
Moore, H. F.
Mott, William E.
Nagle, J. C.
Nelson, J. R.
Nelson, J. R., Mrs.
Newell, F. H.
Newton, Guy D.
Newkirk, B. L.
Nutting, E. P.
Ohle, Ernest L.
Orbeck, M. J.
Park, C. W.
Parker, J. C.
Parker, J. C., Mrs.
Parker, G. S.
Patterson, G. W.
Patterson, G. W., Mrs.
Pawlowski, F. W.
Peterson, Enoch E.
Pinney, J. C., Jr.
Plant, L. C.
Plant, L. C., Mrs.
Poor, V. C.
Porter, F. M.
Potter, A. A.
Probert, F. H.
Probert, F. H., Mrs.
Moore, A. D.
Qualley, O. W.
Raber, B. F.
Randall, H. M.
Raymond, W. G.
Rich, D. L.
Richey, J. J.
Riggs, H. E.
Riggs, H. E., Mrs.
Risley, W. J.
Roberts, E. B.
Rockwell, E. H.
Rodman, W. S.
Rouse, Louis J.
Rovelstad, A. M.
Running, T. R.
Sadler, H. C.
Sadler, H. C., Mrs.
Sawyer, A. R.
Scott, Luther C.
Seeley, Fred. B.
Sewell, A. H., Mrs.
Shaad, Geo. C.
Shaw, H. B.
Shepard, J. F.
Shone, F. P.
Snow, C. H.
Sperr, F. W.
Stevens, F. H.
Steward, R. K.
Swinton, R. S.
Talbot, A. N.
Thomas, H. A.
Thompson, F. F.
Thompson, K. O.
Thompson, Jas. S.

Thornton, J. E.
Thornton, W. M.
Thurstone, L. L.
Tilden, C. J.
Timbie, W. H.
Timbie, W. H., Mrs.
Turneaure, F. E.
Underdown, Wm.
Upthegrave, C.
VanBuskirk, H. C.
VanBuskirk, H. C., Mrs.
Walker, P. F.
Wheeler, E. B.
White, A. E.
White, A. E., Mrs.
Wickenden, W. E.
Wiley, W. O.
Williams, N. H.
Williston, A. L.
Williston, A. L., Mrs.
Wilmot, Sydney
Wilson, C. E
Winslow, A. M.
Wisler, C. O.
Withey, M. O.
Wood, A. J.
Work, Wm. R.
Ziwet, Alexander

MINUTES OF THE TWENTY-EIGHTH ANNUAL MEETING.

THE UNIVERSITY OF MICHIGAN, ANN ARBOR.

JUNE 29–JULY 2, 1920.

The twenty-eighth annual meeting of the Society for the Promotion of Engineering Education was held at the University of Michigan, Ann Arbor, Mich., June 29 to July 2, 1920. The sessions were held in the new Engineering Building. There were 238 in attendance.

MINUTES OF THE REGULAR SESSIONS.

TUESDAY, JUNE 29.

Opening Session.

The meeting was called to order at 2:00 P.M. by J. Raleigh Nelson, Associate Professor of English in the Colleges of Engineering and Architecture, University of Michigan, who introduced Harry Burns Hutchins, President of the University. President Hutchins welcomed the Society to the University. Professor Nelson then turned the meeting over to President Arthur M. Greene, Jr., who responded for the Society. The keynote of the meeting was coöperation.

Roy D. Chapin, President of the Hudson Motor Car Company, read a paper on "Coöperation Between Industry and Education." This was followed by Dr. S. P. Capen, of the American Council on Education, who read a paper on the same subject. Mr. Chapin gave the industrial side of the question, while Dr. Capen presented it from the viewpoint of the educator. A discussion of both papers followed. Dean J. R. Allen gave a short address on the work of the Society of Heating and Ventilating Engineers.

The President announced the following as members of the Committee on Resolutions: W. S. Rodman, *Chairman,* G. A. Goodenough and B. F. Raber.

WEDNESDAY, JUNE 30.

Second Session.

The meeting was called to order at 9:00 A.M. with President Greene in the chair. The report of Committee No. 21 to coöperate with the War Department was read. Charles S. Howe, president of Case School of Applied Science, and chairman of the committee appointed to make a study of engineering experiment stations, then took the chair and the meeting was turned over to a discussion of this matter. It was moved, seconded and carried "That it is the sense and opinion of this meeting, that there is great need for engineering experimentation and research and that we favor federal and state aid for experimentation and research."

President Ira N. Hollis presented a paper on "Coöperation of the Engineering Societies with the Engineering Schools." Discussion.

Third Session.

President Greene called the meeting to order at 2:30 P.M. Dean M. E. Cooley gave a short address on the "Curriculum at the University of Michigan." President C. L. Mees, chairman of the Committee No. 23 to Coöperate with the American Society of Mechanical Engineers read the report of that committee. Discussion. Director J. F. Hayford read the following resolution:

"*Resolved,* That the Executive Committee of the National Advisory Committee for Aeronautics be instructed to undertake, insofar as may be found practicable, the coördination of air dynamic research work in the educational institutions of the country where are located air-dynamic laboratories, to the end that greater general efficiency in carrying out such work among the scattered research units may be realized, unnecessary duplication of effort avoided, and in order that the work in these various research laboratories may be carried forward together with similar working of the government laboratories, as intelligently related part of a general research program."

Vice-President A. A. Potter presented the report of Committee No. 7, Institutional. Professor L. C. Plant read the report of Committee No. 10, Mathematics. Professor E. C. Kiefer read a paper, "Courses in Engineering Problems," and Professor E. F. Coddington read "Correlation of the Army Intelligence Tests with Academic Work of our First-Year Students." Discussion. In the absence of the Chairman, Professor G. W. Stewart, Dean W. G. Raymond presented the report of Committee No. 11-A, Physics, and Professor O. H. Basquin presented the report of Committee No. 13, Mechanics and Hydraulics. Dean P. F. Walker read the report of Committee No. 14, Economics, in the absence of the chairman, Professor C. C. Williams. The report of Committee No. 11-B, Chemistry, was read by title.

THURSDAY, JULY 1.

Fourth Session.

President Greene called the meeting to order at 9:30 A.M. and invited Vice-President Potter to take the chair. Professor F. H. Newell read a paper on "Pay of Engineering Educators." Discussion. Mr. C. S. Coler presented a paper on "Relation between Technical Schools and Industry" and Mr. H. B. Shaw a paper on "Coöperation of Public Utilities." The Secretary reported the action of Council, namely, that the next meeting of the Society be held at Yale University beginning June 28, 1921. Upon motion the Society voted to accept this recommendation. The Nominating Committee reported as follows:

For officers to serve one year:

For President: M. E. Cooley, University of Michigan.

For Vice-Presidents: T. U. Taylor, University of Texas, H. S. Evans, University of Colorado.

For Secretary: F. L. Bishop, University of Pittsburgh.

For Treasurer: W. O. Wiley, New York City.

For members of the Council to serve for three years: J. F. Merrill, University of Utah; J. H. Felgar, University of Oklahoma; W. H. Timbie, Massachusetts Institute of Technology; L. L. Thurstone, Carnegie Institute of Technology; R. S. King, Georgia School of Technology; C. C. Williams, University of Kansas; J. C. Tracy, Yale University.

Dr. A. L. Williston proposed the following resolution which upon motion was accepted:

"*Resolved,* That it is the sense of this meeting of the Society for the Promotion of Engineering Education that the Committee on Engineering Experimentation proceed with its study of plans for the furtherance of Engineering Investigation and Research, and that it endeavor to harmonize the differences of the existing plans for this purpose, if possible, or if this be found impracticable, that it recommend some plan of its own for consideration of this Society at a future meeting."

Dr. L. L. Thurstone, Chairman of Committee No. 22, Intelligence Tests presented the report of that committee. Professor J. F. Shepard read a paper on the "Rating System for Faculty at the University of Michigan." Discussion.

Fifth Session.

The meeting was called to order by President Greene at 2:00 P.M. In the absence of Professor A. E. Kennelly, Chairman of the Committee on Degrees, Professor F. W. Sperr presented the report of that committee. Professor E. H. Rockwell read Dean G. C. Anthony's paper on "Interdepartmental Coördination."

President Greene appointed President Ira N. Hollis, as a classmate of the President-Elect at the Naval Academy, and

President F. W. McNair, Senior Past-President of the Society in attendance at the meeting, to escort President Cooley to the chair. In presenting the President-Elect to President Greene, President Hollis said: "Mr. President we have the honor of presenting to you your successor in office. Having been duly elected president of this Society, I am sure by his skill in navigating through treacherous channels, he will prove an honor to the profession and this Society." President Greene then introduced the new president to the Society and he accepted the office with a few remarks.

Professor C. W. Park, Chairman of Committee No. 12, English, presented part of the report of that committee, and Miss Sada A. Harbarger, a member of the Committee, reported on the other part.

The Treasurer, Mr. Wiley, presented his report for the year 1919–20 and recommended that each member be assessed $1.00 for two years in order that the increased cost of printing may be met. The Society voted to accept this recommendation and to levy the assessment.

Professor A. E. White read his paper on "Department of Engineering Research, University of Michigan," and Professor W. H. Timbie presented "Coöperative System of Electrical Engineering Department, Massachusetts Institute of Technology." Professor A. N. Talbot discussed the Society's work at the U. S. Naval Academy. Professor A. H. Fuller, Chairman of Committee No. 15, Civil Engineering, presented the report of that committee. Discussion. Professor A. H. Blanchard presented a paper on "Highway and Highway Transport Education." In the absence of the Chairman, C. Francis Harding, Dean O. J. Ferguson read the report of Committee No. 17, Electrical Engineering. Professor F. W. Sperr presented the report of Committee No. 18, Mining Engineering.

Annual Dinner.

At the annual dinner President Greene read his presidential address, "Requirements: Coöperation between Preparatory Schools, Colleges and the Industries as Viewed from the Standpoint of the Educator." Dr. Marion LeRoy Burton having just assumed his office that day, as President of the University of Michigan, the Society presented him with a basket of flowers. President Burton responded to this with an address.

The Committee on Resolutions reported as follows:

Resolved, That it is the sense of this meeting of the Society for the Promotion of Engineering Education that the Committee on Engineering Experimentation proceed with its study of plans for the furtherance of Engineering Investigation and Research, and that it endeavor to harmonize the differences of the existing plans for this purpose, if possible, or if this be found impracticable, that it recommend some plan of its own for consideration of this Society at a future meeting.

The Society for the Promotion of Engineering Education deeply appreciates the many courtesies extended by the officials and members of the faculty of the University of Michigan and others who have been instrumental in making the convention of nineteen twenty so pleasant and profitable. Therefore be it

Resolved, That the thanks of the Society be hereby tendered to the regents of the University, Past-President Hutchins, President Burton, Dean Cooley, Professor Nelson, and other members of the Faculty and Local Committee for the admirable provisions made for the reception and entertainment of its members and guests; to the Michigan Union for the excellent facilities and service so graciously rendered; to the Regents of the University for the very delightful luncheon furnished at Vivian House; to Mrs. G. W. Patterson for her charming hospitality to the ladies at "The Orchards"; to Professor Earl Moore for the arrangement of the organ recital in the Hill Auditorium; and to the fraternities which so kindly opened their houses.

Resolved further, That the thanks of the Society be expressed to the Detroit Edison Company, and particularly to the President, Mr. Alex Dow, for the courtesies extended at Vivian House, and for the opportunity afforded for inspection of the Conners Creek Power Station; to the business men of Ann Arbor for their generous loan of automobiles; to the Hudson Motor Car Company, Morgan and Wright Tire Company, and Parke Davis and Company for privileges of inspection of their plants; and to the City Engineer of Detroit, Mr. Hubbell, for the cordial arrangements for the tour of the Sewerage System.

WHEREAS, The Council of the Society for the Promotion of Engineering Education has recently voted to present to the Pan-American Union a set of its *Proceedings* and to exchange its publications, and

WHEREAS, By this action it has shown its interest in education throughout the American Republics and its desire to be of service, be it

Resolved, That the members of the Society assembled at the annual convention held at the University of Michigan express their approval of this action, and be it

Resolved, That we express to the educational authorities of the South American Republics our desire to coöperate with them in their engineering educational problems and to be of service in any way, and that we desire to promote the most cordial and friendly relations with them, and be it

Resolved, That we request our members to study the engineering records of these countries to the end that we may be of service when requests come from their governments, and finally be it

Resolved, That these statements be transmitted to the Pan-American Union and to the Bureau of South American Republics of the State Department of the United States for transmission to the proper authorities.

President Greene, in a few words, turned the office over to the President-Elect Mortimer E. Cooley who, after ascertaining there was no further business to come before the meeting, declared the convention adjourned.

MINUTES OF COUNCIL MEETINGS HELD JUNE 29 AND JULY 1, 1920.

Meetings of the Council were held on Tuesday, June 29, and Thursday, July 1. Members who attended these meetings are: Frederic Bass, F. L. Bishop, H. S. Boardman, E. F. Coddington, A. M. Greene, Jr., John F. Hayford, C. S. Howe, O. A. Leutwiler, F. W. McNair, W. E. Mott, J. Raleigh

Nelson, W. G. Raymond, W. J. Risley, E. H. Rockwell, W. S. Rodman, C. J. Tilden, and W. O. Wiley.

The motions acted upon were as follows:

1. That the invitation to hold the next meeting of the Society at Yale University be accepted. Carried.

2. That the 1921 meeting at Yale University begin Tuesday, June 28. Carried.

3. That the Treasurer's report be referred to the meeting. Carried.

4. That the recommendation of Mr. Wiley to the effect that each member be assessed $1 for a period of two years in order that the Society may be able to pay up past indebtedness, be increased to $2 for two years. This motion amended that it be $1 for two years. Amendment carried. Motion as amended voted upon and carried.

5. That the next meeting of the Society be held in the winter. Lost.

6. C. J. Tilden was elected to serve for three years on the committee of the American Council on Education.

7. That a complete set of the *Proceedings* be given to the Pan-American Union. Carried.

8. That the Committee on Resolutions draw up and present to the meeting resolutions pertaining to the relations between this country and South American countries.

9. That membership in the John Holmes Safety Association be continued. Carried.

10. That the Society for the Promotion of Engineering Education not take part in the meeting of the American Association for the Advancement of Science. Carried.

11. That the resignations of charter members be not accepted. Carried.

12. That the chairman of each committee be considered as a coöperative editor with the Secretary in editing the bulletin. Carried.

13. That the reports of the Committees on Physics and Mechanics be printed in the *Proceedings* only after further editing. Carried.

14. The following applicants were recommended to the Society for election:

Bragg, Edward M., Cade, Claude M., Dirks, Henry B., French, Robert W., Kiefer, Earl C., Kolyn, Marion D., Jasper, Thomas McL., Peterson, John C., Ward, Clayton N., Wisler, Chester O., University of Porto Rico.

15. The following budget of income and expense for the coming year was reported by the Executive Committee and adopted by the Council:

ESTIMATED RECEIPTS.

From current dues, individual	$6,715.00
From current dues, institutional	710.00
From back dues	800.00
From advertising	1,200.00
From sale of publications	150.00
Estimated receipts	$9,575.00

ESTIMATED EXPENSE.

A. The Michigan meeting (1920)	$ 400.00	
B. *Proceedings*, Vol. 28	1,800.00	
C. ENGINEERING EDUCATION, Vol. XI	2,000.00	
D. Committee Expenses	150.00	
E. Treasurer's honorarium	200.00	
F. Secretary's honorarium	1,000.00	
H. Clerical assistant	1,500.00	
I. Sundry Printing	250.00	
J. Postage and Express	200.00	
K. Telephone and Telegraph	25.00	
L. Office Supplies	75.00	
Estimated expense		$7,600.00

Respectfully submitted,
F. L. BISHOP,
Secretary.

REPORT OF TREASURER, JUNE 28, 1920.

Receipts.

Cash on hand, June, 1919		$1,068.71
“ received, Individual Current Dues	$4,446.00	
“ “ “ Back Dues	631.50	
“ “ Institutional Current Dues	695.00	
“ “ “ Back Dues	97.50	
“ “ other sources	1,373.61	$7,193.61
		$8,262.32

Disbursements.

Annual meeting	$270.93	
Committee Expenses	98.54	
Treasurer's Office, on account	25.00	
Secretary's Office, on account	800.00	
Secretary's Clerical Assts.	1,200.00	
Sundry Printing	183.42	
Postage and Expressage	188.02	
Telephone and Telegraph	33.61	
Office Sundries	49.08	
Vouchers (7) amount returned	49.05	
“ (18) “ “	4.29	
a/c Payable	3,977.74	$6,479.68
Balance on hand		$1,782.64

Assets.

Accounts Receivable		
Individual Current Dues	$ 944.00	
“ Back Dues	1,800.00	
Institutional Current Dues	70.00	
“ Back Dues	97.50	
Members and non-members	470.00	
Dr. Bishop's Office	59.67	
	$3,441.17	
Inventory	2,546.00	
Cash	$1,406.03	
“ Life Member Fund	497.26	
“ Dr. Bishop's Office	150.00	$8,040.46

Liabilities.

Members paid in advance	$ 92.00	
Due Dr. Bishop	200.00	
New Era Printing Co.	2,913.12	
A. E. P. Kerr Co.	338.50	
Whitehead & Hoag	45.35	$3,588.97

REPORT OF THE SECRETARY.

I have made no attempt in this report to cover all the activities of the Society, since these are covered to a large extent by the reports of the committees. Consequently, this report considers mainly only those things which have to do with the Secretary's office.

MEMBERSHIP.

There have resigned or been dropped for non-payment of dues during the past year, 108 members and 6 deaths. Of those who have resigned, sixty per cent. have entered commercial work and state that they are no longer interested in educational problems. Thirteen per cent. have resigned on account of failure of institutions to increase salaries. There have been added 112 members. There are 11 applications for membership, making the total new members this year, 123, and the total membership, 1,522.

It is interesting to note the number of new members added for the past seven years:

1920....	123	1918....	79	1916....	102	1914....	134
1919....	90	1917....	95	1915....	129		

This shows, of course, the immediate effect of the war on the number of new members. This is perhaps even more strikingly illustrated by the number who have left the Society.

1920....	114	1918...	106	1916.....	50	1914.....	59
1919....	91	1917...	78	1915.....	78	1913.....	51

During the war a number of men were carried on the rolls who would have been dropped under ordinary conditions.

These figures show that the number of new men added has almost reached the number added previous to the war, while the number leaving the Society has probably reached the maximum.

METHOD OF COLLECTING DUES.

At the suggestion of the treasurer, Mr. Wiley, the Council recommended that the secretary's office take over the responsibility for the collection of dues and some of the other duties pertaining to the Treasurer's office.

In July, 1919, bills were sent to all members showing their total indebtedness to the Society. This was followed by a second notice in October, and a third notice in January. Following the instruction of the Council, the Secretary wrote a personal letter to everyone owing $12 or more and at the same time called the attention of the Society's representative in the institution in which these men were located to the indebtedness of their co-workers. This letter was very satisfactory in bringing results and especially in finding the correct addresses of some of these men who had left the teaching profession. A fourth notice was sent the latter part of May to all members owing $8 or less.

SECTIONS.

The Council at the Baltimore meeting voted that the Society authorize and encourage the formation of sections in cities, states and other geographical divisions. Vice-president Potter was authorized to act as chairman of the committee to encourage the formation of these sections. Through the energetic action of Dean W. E. Mott, of Carnegie Institute of Technology, the first section was organized in Pittsburgh with Professor P. M. Dysart, Schenley High School, as chairman, and the late Professor L. H. Harris, formerly Assistant Secretary of the Society, as Secretary. Upon the death of Professor Harris, Professor C. B. Stanton, of Carnegie Institute of Technology, assumed his duties. The other sections which have been formed are the Georgia-Tech Section with Professor R. S. King as Secretary; and the Kansas-Nebraska Section with Past-President G. R. Chatburn as chairman, and Professor R. A. Seaton, Kansas State Agricultural College, Secretary.

Other districts have held preliminary meetings looking toward the formation of sections. I quote from a letter from St. John's University, Shanghai, China: "Here at St. John's we are looking forward to the opening of work in Engineering in the near future but our plans are not sufficiently advanced to justify a formal announcement. Until that announcement can be made I have no standing as a teacher of engineering subjects although I am under appointment as dean of the new department of engineering. I very much hope though that it will be possible to arrange for a section of the Society out in China and I will do everything I personally can to help bring this about."

PUBLICATIONS.

The Society has for a number of years been issuing a bulletin, Engineering Education, ten times a year, and the annual volume of PROCEEDINGS. Both, I believe, have contributed materially to the promotion of engineering education. During the past year on account of the very decided advance in the cost of printing it has been necessary to limit engineering education to the smallest possible number of pages. The volume of PROCEEDINGS was considerably reduced in cost by eliminating from it material which is ordinarily published in the year book. Thirty pages were thus eliminated. A notice received the first of May from the publishers indicated that the price will be further increased during the coming year. Following the example of other engineering societies, it will be necessary for the Society to consider very carefully its printing bill for the forthcoming year.

The Secretary's office answers a large number of inquiries every year and more especially during the past year, from institutions desiring men and from teachers who desire positions. A number have been placed in this way. It is also interesting to note that we often receive inquiries from prospective students in different parts of the world in regard to engineering schools. In such cases, the questions are answered to the best of our ability and then referred to the nearest engineering school for further information.

This Society is the only engineering society devoted to education. Other national engineering societies are devoted almost exclusively to the technique of the profession. They have, in nearly every case, committees on education as all national engineering societies recognize the importance and direct connection between the proper education of the prospective engineer and the growth of the profession. It has seemed to the Secretary that some method of coöperation should be developed.

The discussion by President Hollis, of the Worcester Polytechnic Institute, on the relation of this Society to other engineering societies, brings directly before us this question which is, I believe, one of the most important for the Society to settle.

Committee Work.

The committee work of the Society shows every year a distinct advance by each one of the committees and keeps before the teaching profession constantly the various problems in the different branches of engineering. A review of the work of some of these committees shows marked results and the work has produced a distinct effect upon the curricula of engineering schools as well as the method of presentation of the different subjects.

President Greene appointed a new standing committee on drawing during the year. One of the most important problems ever undertaken by this Society was presented to it in the form of the memorial from The Ohio State University.

"Columbus, O., Dec. 2, 1919.

"To the Council of the Society for the Promotion of Engineering Education.

"*Gentlemen:* At a meeting of the faculty of the College of Engineering of Ohio State University dated October 28, 1919, it was voted to request the special committee on Engineering

Experiment Station Legislation to memorialize your council asking that as soon as possible a committee of the S. P. E. E. be appointed whose business it should be to devise some method whereby the present deadlock between the Land Grant Colleges and the separate State Universities on the matter of Engineering Experiment Station Legislation may be broken.

"The federal government is favorable to this sort of legislation as evidenced by the bills that have from time to time been introduced into Congress. But there is no promise of any accomplishment so long as opposition from either faction interested in engineering education exists.

"Passed unanimously by engineering faculty on Dec. 2, 1919.

(signed) "CLYDE T. MORRIS,
D. J. DEMEREST,
F. C. BLAKE, *Chairman.*"

Respectfully submitted,
F. L. BISHOP.
Secretary.

ADDRESS OF WELCOME.

BY HARRY BURNS HUTCHINS,

President, University of Michigan.

Members of the Society for the Promotion of Engineering Education: In behalf of the regents and the faculties of the University of Michigan, it is my pleasure to extend to you a most cordial greeting, and a most hearty welcome to these halls. We feel honored by your presence. It is an honor to any university to entertain a body of men who are having the influence upon scientific and, particularly, scientific engineering education that this body has had and is having, and will have in the future. We trust that your meeting here will be full of profit and not entirely without pleasure.

I hardly know what to say to you this afternoon. I supposed until about an hour ago that this duty would be performed by the dean of our engineering college. At the time the program was made, I expected to be out of town upon the occasion of your meeting, but the dean discovered about an hour ago that I was here and said that as the President of the University I must appear. I replied, "I don't know what to say, I know nothing about your Society or about engineering education, except in a general way." He told me what I have just said to you about your influence upon engineering education, and I said, "If I speak to these gentlemen, I must have a 'brief,'" and here is the "brief" which is put into my hands. With this before me, my friends, I could talk indefinitely for it is a complete outline. But notwithstanding the "brief," my remarks will be brief.

As you are our guests, I think it would be appropriate to call your attention to a few of the high spots, so to speak, in the history of the University of Michigan, and particularly in the history of the College of Engineering of this University. The university organic act, under which we are now operating, was passed in 1837. Previous to that, as early as 1817, the University was planned and there was an act under which a school functioned under the name of the University of Michigania in the neighboring city of Detroit. This was a unique but comprehensive piece of legislation. It provided for a university plan that was broad and complete in all of its details. Indeed, the University today has not filled out completely the plan in the act of 1817. The style of the act is pedantic. It is full of classical terms, but it has real merit.

In 1837 the organic act of the University of today was passed. It is of interest to this Society, I am sure, to know that engineering was included in the original organic act. So on paper, at any rate, we have had an engineering school here since 1837. As a matter of fact, engineering instruction has been given here, according to Dean Cooley's "brief," since 1853. In 1853 the first professor of engineering was appointed and the first class was graduated in 1860. The class numbered two and Dean Cooley tells me that these men are still living.

In point of establishment, the University of Michigan is the oldest of the state universities, and the Engineering College probably is the third or fourth in the country, Rensselaer being first, I suppose, I am not certain as to the others.

Military engineering was established here in 1861, but it did not get a firm hold and soon dropped out. A school of mines was also established later as a part of the Engineering College or Engineering Department, as it was then called, but the Legislature later established a school of mines in the Upper Peninsula, and instruction in this field was then abandoned by the University.

A course in mechanical engineering was established here in 1868, probably the first course in the country in that subject. Up to that time instruction in engineering in the University had been confined, very largely, and perhaps entirely, to the field of civil engineering. However, the mechanical engineering instruction did not long persist. For some reason, it was abandoned, and was not revived or reëstablished until 1881, the year Dean Cooley came to the University.

In 1875 there was also a sporadic attempt to establish a department of architecture in connection with the Engineering College. But the Legislature failing to give the necessary appropriation for the continuance of the department, it was abandoned two or three years later, to be reëstablished, however, in 1905. At the present time, the College of Engineering in the University embraces practically all of the modern branches of engineering. At any rate, it is so stated in my "brief." The departments now functioning are the following: Civil Engineering, Mechanical Engineering, Electrical Engineering, Chemical Engineering, Marine Engineering, and Naval Architecture, Architecture, and Architectural Engineering.

The College is one of the largest in the country. The attendance last year was 2,038, and adding the attendance at the Summer Session, 2,170.

The University of Michigan almost from the first has been noted for its cosmopolitan character. I came to the University as a student in 1867. At that time there were, 1,229 students, as I recollect. There were the three departments, as they were called then, the three departments authorized in the original organic act. Others have been added since. They were the Department of Literature, Science, and the Arts, the Department of Engineering, and the Medical Department. The 1,229 students came from twenty-nine different states. That is my recollection. I have not the figures before me. Four territories were then represented in the student body, and five foreign countries, which is the cosmopolitan record for that time. At the present time in the student body, we have representatives from every state in the Union, and from thirty-four foreign countries. Some foreign countries send large delegations. We have from South Africa, for example, forty or forty-five students; from China, sixty or seventy. The Engineering College is cosmopolitan in character, as is the whole University. Engineering students, according to my " brief," come from every state in the Union, except four, and from the District of Columbia, Hawaii, Philippines, Porto Rico, and from eighteen foreign countries. So you see the students coming to this University and to the Engineering College have the advantage of the world. In this there is a distinct advantage, particularly for engineering students.

Your problems are fast becoming world problems. When I was an undergraduate, the Engineering Department was small; engineering problems were just beginning to develop. We were not awake to the importance of the profession, and to the manner in which it would thereafter figure in the development, not only of this country, but of the world. But the problems are now with us in large numbers and many are of supreme importance.

A word as to the sources of revenue of the University may not be out of place. This is the oldest of the state universities. The University of Indiana has a paper existence somewhat older than the University of Michigan, but the University of Michigan is the oldest of the state universities to function. The support comes largely from the state, very largely from the state. The regular income is derived from a tax upon the taxable property of the state. This at present in round numbers is a million seven hundred thousand dollars. The theory of the legislation providing for the tax is—and I submit that it is a sound theory—that the income of the University should increase in proportion to the increase in the value of the taxable property of the state. As the value of the property goes up, the income of the University automatically increases. This income, together with the tuition received from students, and the income from certain endowments, is used for the current expenses of the University. For special expenditures as for buildings, we go to the Legislature for special appropriations. The last Legislature, for example, gave us over two million dollars for special purposes, special buildings. Dean Cooley says this building is not large enough for him, and I suppose my successor will in the near future have to go to the Legislature for a special appropriation for a larger engineering building.

This University, as must eventually be the case with every state university, seeks to supplement its income from the state by private donations and bequests. There is no reason why the state university should not also be an endowed university. And that we have been measurably successful is evidenced by the fact that during the past eleven years we have received from alumni and friends over three million dollars.

The state universities are the universities of the people. They touch the people closely. They are not bound by tradition. They can keep abreast of the times without being subjected to criticism. They are the universities that in my judgment will take a leading place in the future. Of course, they will have great problems, grave problems. If my successor—he is too wise a man to think so—if he thinks the problems have all been solved, he is mistaken. I think the problems of the future will be more difficult and more important than those of the past. One that is even now pressing is, what shall we do with the flood of students that is overrunning every state university in the land? We have enrolled this year 9,401 students. My successor, President Burton, says that that one student is his daughter whom he sent here from Minnesota. The state university is the university of the people; the people will support it. How far will they go in the support of the higher education? This is one of the great questions, and it will be the work of the future university presidents to convince the people of their duty in this regard.

That is all I have to say. I will close by reading the last paragraph of Dean Cooley's "brief": "The oldest state university and one of the earliest engineering schools in the country welcome the Society for the Promotion of Engineering Education."

RESPONSE TO ADDRESS OF WELCOME.

BY ARTHUR M. GREENE, JR.,

President of the Society.

President Hutchins, it is a great pleasure for me, as a representative of this society, to respond to this message of welcome. We appreciate very much the fact that you have come at the end of a very strenuous time, your commencement season, and also at just about the time when you are to give up the reins of office to another, as one of your last acts is to welcome us to your university. The Society feels that you and the committees have planned for us a great and glorious time, and we appreciate this very much.

I personally have two messages of appreciation to bring, one because I happen to be connected at the present time with the oldest English-speaking Engineering School, Rensselaer, and you happen to be the oldest state university to give engineering. So for that reason, I am glad that I am present this year to respond to these words of yours.

In 1845, B. Franklin Greene, the Director of Rensselaer, brought into vogue at the Institute new methods, and just two years after that time, according to the records, Harvard and Yale and your own institution offered engineering to the student. We offered civil engineering, and it was not until the sixties that other branches of the engineering of the civilian were offered, mechanical, mining, and metallurgical, to be followed in the eighties and nineties by electrical engineering and chemical engineering. My thought goes back, in looking over the work of graduates of these engineering schools, who went out in the forties, fifties, sixties and in studying that which they did for the development of the transportation, and the resources of this country, to question whether or not we are not devoting time at the present to too many specialties. When we think of the great works which they did with general engineering training only, I think we might well pause, Mr. President, and ask ourselves, are we not trying to cover too much of the minutiæ of the engineering and leaving undone the basic facts, the great training which the older men got for their future work.

There is another personal reason, Mr. President, that I have for being glad that I am here this afternoon, and that is that although not a son by blood, I am by training and influence a son of that class of the United States Naval Academy which gave Bartlett, Cooley, Hollis, and Spangler, to engineering education, the class of 1878. The first of these who has devoted his life to the training of naval engineers, the other three to the training of civilian engineers. Professor Spangler to whom I owe much and to whom I wish to give this public recognition, by his method and his manner of attack, leads me to think that if we could only follow the work of the professors at the Naval Academy who held chairs there during the years 1874 to 1878, we would do well in our educational methods of today.

As a society, we are glad to be here in order to see the work in engineering education which Dean Cooley and his faculty have done. It is a great inspiration for all of us to visit, as we do each year, the different universities, studying their methods, studying their equipment, studying their schemes of student government, so that we may take home with us new thoughts, and changes for our own curricula, or equipment. This to me, with the pleasant social intercourse of these meetings, is probably the most important factor in making them what they are to each one of us. We are going to hear later in our sessions, many papers which will be presented and read, and nothing may be done with them, but the friendships which are formed, and the inspirations which we get are never lost.

We are glad to be here to share with you the early use of the wonderful new Union Building. Some of us have enjoyed the Huston Club at Pennsylvania, the Harvard Union at Cambridge, or similar buildings at Yale, and Princeton, and have realized that the club feature was the utmost in the minds of those who planned the buildings. In your building, you have brought into being some of the things which they lack and you have all the important features of an up-to-date modern club, and this, we are sure, will be helpful to the student body here, and more particularly to the alumni who may come back to renew their attachment to Alma Mater.

In closing, Mr. President, I want again to thank you for your cordial words, and also extend to the members of the various committees our appreciation for the work which they have done for our welfare and comfort at this convention.

Ladies and gentlemen: In planning for the convention we wished to strike the keynote of "Coöperation" between the schools, the colleges and the industries. We wished to see if there were not some things which we could all do to produce a more harmonious unit, and in order to understand something of what the industries demand, we wished to have our keynote address from one who, a college man, and an alumnus of this university, is handling, is dealing, is using our product, the graduate engineer. We feel ourselves very fortunate to have with us this afternoon Mr. Roy D. Chapin, the President of the Hudson Motor Car Company. It is with great pleasure that I present him to you.

INTRODUCTION OF PRESIDENT-ELECT.

President Hollis: Mr. President, we have the honor of presenting to you your successor in office. Having been duly elected president of this Society, I am sure by his skill in navigating through treacherous channels, he will prove an honor to the profession and this Society.

RESPONSE OF PRESIDENT-ELECT.

Mr. President, Members of the Society: Election to the presidency of the Society for the Promotion of Engineering Education is an honor which cannot be declined—particularly after one has been elected—however one may feel about it. I thought that I had taken precaution which would insure the selection of a younger and less busy man. There are dozens of men in this society who could serve the society far more energetically and, I think, far more wisely. But the best of plans *gang oft agley.* I am one of your older members. I think that I have, perhaps, been longer in the teaching profession than any other member of the society, certainly any member here. In another year I will have been teaching forty years in one professorship. I started at twenty-six. Please do not ask me to make the addition.

Let me take this opportunity to say something suggested by one of the papers read this morning—the paper on coöperation with the industries. It must be twelve or fifteen years—Professor Allen will remember as he was with me at the time—since I went to one of our large manufacturing companies with what I considered an excellent idea. I made the journey of three hundred miles on purpose to discuss coöperation with the president and other officers of the company. We were received very kindly, and when I explained to them the purpose of our visit they expressed themselves as much interested.

I pointed out that engineering colleges were in a sense manufacturing establishments, that the industries were the market for our product, that none of the industries up to that time had taken the slightest interest in the character of the product being turned out for them, that the colleges were working out their salvation to the best of their ability, and that, so far as any help from the industries was concerned, they were working in the dark.

I then proposed a trial of this plan: that the company detail to this university one of its good men in some particular line of work, and we would detail to the company one of our men in the same line of work; they to pay the salary of their man, and the university to pay the salary of its man. After one year the men would return to their respective employers.

The plan contemplated similar arrangements in other lines of work for successive years, and also with other companies. In that way I thought the members of our teaching staff might keep in close touch with manufacturing developments, and the manufacturers in close touch with the colleges. There would naturally be an exchange of information and of views which could not fail to be of mutual benefit. This, it seemed to me, would be a very proper arrangement, and would be coöperation in the fullest sense of the word. But nothing came of it. The fact that in recent years the industries have been showing an interest in the work of the colleges is very gratifying to all college men. We appreciate their interest and thank them for coming forward with their ideas.

Looking backward, one finds that very great changes have taken place. Forty years ago the engineer graduate did not know where to find an opening. He frequently had to wait weeks and months for it. Today the opening awaits the college graduate. They are sought and engaged months before graduation. The conditions have indeed changed.

Looking forward, it is very difficult to predict what will come about, even more difficult to predict what should come about. But we can judge the future from what has happened in the past. One definite thought has crystallized out of my nearly forty years of teaching experience. It is this: We have given altogether too much attention to preparing the young man to do some particular thing. We should have given more attention to preparing the man to live the life he should live in his family and in his community. What the world needs is a better and more rational civilization. The most hopeful sign I see for engineering education is that the schools are all coming to the same thought. The industries, particularly the manufacturing industries, must inevitably reach the same conclusion, if only for their own interests.

We have been exploring a wide field, each one in his own direction. The results of these explorations during the past thirty-five or forty years are truly wonderful. You can find nothing more wonderful in written history. Dr. Hollis referred to the civilization that existed prior to the building of the pyramids. Relatively, it may have been as wonderful as this one, but we do not know. The stories of the Arabian Nights pale in comparison with the achievements of the past twenty-five years. The civilization of the world, as we know it, has been largely created through the efforts of scientific men—of engineers especially. Science has let loose very great forces which are raging up and down the earth uncontrolled. The task before the world today is to get those forces under control. That is our problem for the next twenty-five years.

Teachers are artists—or should be. All are engaged in artist's work,—molders in clay. It is human clay at its most plastic stage, between boyhood and manhood. Young men and women can be greatly influenced while in college. A great responsibility, therefore, rests upon the teacher. Parents all through the land entrust to us their children to make of them men and women. Are we fully sensible of our responsibility? I say we are artists, and that we have the most precious material in the world out of which to make our image. The wise teacher has great powers for doing good. The time to do good is now.

If I have any thought at all for this coming year, it shall be along those lines. You must not expect me to encourage you to sweep into new fields, but rather to get a line of sight from the past to guide us in what I feel should be our immediate task, namely, an effort to reconstruct some parts of our engineering education.

Mr. President, and Gentlemen, I am very appreciative of the honor you have conferred on me, and shall hope to be able to rise to what I conceive to be the duties of the office. This has been an inspiring meeting. I am impressed by the amount of thought that has been given to the preparation the papers. Even more am I impressed by the interest which has kept the full attendance at all meetings. I shall strive to merit your confidence, the way towards which has been so clearly indicated by my very able predecessor. Gentlemen, I thank you.

PRESIDENTIAL ADDRESS.

REQUIREMENTS: COÖPERATION BETWEEN PREPARATORY SCHOOLS, COLLEGES AND THE INDUSTRIES AS VIEWED FROM THE STANDPOINT OF THE EDUCATOR.

BY ARTHUR M. GREENE, JR.

The engineering college stands between the preparatory school and the industries, receiving from one and giving its product to the other. The relation which it should bear to each, the coöperation which it should offer and expect, and the unity of development which the three should manifest are the subjects of this discussion.

In developing these thoughts of coöperation it is necessary that certain admitted premises be stated or the conclusions will be invalid. Certain fundamentals are accepted by some as the basis for the plan of engineering education. There are two distinct views regarding the preparation for this training. Some believe that such colleges should be planned to take the product of our average high school or preparatory school and in a limited time produce men suitable for individual work in the industries. Some believe that the schools should demand preparation similar to that required by law and medicine and hence that an academic degree or two years of college work should be required for entrance to the school of engineering. The former is the belief of the greatest number of schools as indicated by their requirements for entrance. In this discussion the assumption is then made that the college is to accept graduates from the high school. The other premise which is assumed is that the colleges are training men who may enter any portion of the particular field of engineering which they have selected. The granting of these two conditions leads to the following developments.

The average high school or preparatory school! What is it doing? What can it do? What should it do?

The engineering school of which we will speak as the college, requires the same thing from the high school as that which industry demands from the college: graduates who shall be taught to reason about problems which are related to the studies they have taken, and studies which should be selected so that they may be utilized in the scheme of after development.

The high school should so select its subjects that the preparation may be equally of use to the pupil entering college or to the pupil entering commercial or industrial life. Many high school pupils do not know what they will do when their course is completed. Many alter their plans due to changed circumstances. In any case the fact remains that the pupil must think, must judge, must reason, must act in any field which he enters.

The plea is made that greater progress could be attained if a more complete drill could be given the pupils in the application of the fundamental high school studies so that these subjects become real to them and they may reason better from this training. Using a word from our last convention, "motivation" should be introduced to stir up interest but many original problems must be given to cause the pupil to do independent thinking. Studies should be made more real to the pupil and he should be trained in making decisions through reasoning based on this work.

Take for instance arithmetic: our trouble at Rensselaer has been that the freshman has failed to realize in the grades or high school what percentage is. When it is necessary for him to reduce constituents of a chemical compound to percentage he appears as ignorant as one who had never heard of percentage. In many cases he is like the man who said that he only made one per cent. when he bought something for one dollar and sold it for two. This seems to be a general condition and is probably due to the fact that teachers fail to emphasize the real meaning of such things. In many cases this may be caused by failure of the teacher to realize this meaning. Without experience on the part of the teacher the subject can rarely be made real to the pupil.

The work in geometry is often such that the real value of this study is not understood. The force of the geometrical proof as a method of logic to be applied in other places is not made clear, the use of the proof in the solution of originals and the method of turning to the text for references in new problems seem to have been forgotten by the teacher. Rarely can engineers work out problems in railroad curves, or vector analysis, in valve diagrams or turbine design, in mechanism or descriptive geometry without the use of some of the theorems or constructions used in geometry. What is more important students can rarely pass a day in which they do not apply the mode of attack and reasoning gained by the study of geometry in the solution of some practical problem.

The work in algebra is important in teaching us the methods of literal calculation. To me, its importance is due to the fact that it furnishes us with tools with which to work. The methods used in the reduction of fractions, in factoring, in the study of the three series, in quadratic solutions, are all of value in the later work of college algebra and are to be applied in everyday practice in the solution of engineering problems. The great trouble again seems to be the lack of facility in handling the work done. Although the ground covered in the high school is not great thoroughness is lacking after the completion of the limited work.

The question of coöperation between the schools and the colleges in the matter of mathematics is one which resolves itself into a more thorough drill in the applications of arithmetic, geometry and algebra by those who appreciate and know the work dependent upon these. The failure to realize the meaning of the mathematical subjects studied appears to me to be the lack of the present day matriculates of our colleges.

The effect of this more complete training on the pupil who does not go to college but who enters business life should be considered. This class represents the larger portion of the high school graduates. It is believed that this training prepares such persons for more successful careers. The statement of a problem to be proved, the collection of possible facts or theorems to be used, the selection of the correct facts for the proof, followed by the actual proof can be used in daily commercial or industrial life by the young graduate from the high school. Judgment and reasoning are the necessary steps in the ladder of success here as in engineering.

The work in English in the preparatory school as in the engineering college must be carried on with diligence and with constant drill. The coöperation hoped for here is merely that which should exist between institutions in which a subject begun in one is continued in the other. If the high school could inculcate the desire for good reading so that this habit were formed before the pupil came to the college broader work could be done with many of our men who at present are too narrow on completing the high school work. Spelling and penmanship should be taught more thoroughly with an ever-present drill.

The other language work of the schools is to aid in the study of English and to give the engineering student a working knowledge of some foreign language. That the language should be studied more completely can not be denied but the amount is questionable. In some engineering colleges foreign language is being omitted from the curriculum and required for entrance. This may be done but the science reading for which the foreign language is given in college can not be accomplished in the high school with much success because of the youth and inexperience of the pupils. The reading of foreign non-scientific literature can be carried on in the preparatory schools with success and such preparation will reduce the college work, but the engineering school should give scientific reading for all men even though this be limited in amount. The great need is to be able to scan a foreign journal for articles of interest and value.

In the sciences, the work of our engineering student indicates that a more thorough drill in the fundamentals is required in the preparatory school. The work shows that greater intensity rather than more extent is needed. The men with excellent science training in many of our high schools are more interested in the later developments of science than in the "hum drum" elements on which the science rests and in which the pupil needs thorough grounding. The teachings of these fundamentals is rather irksome to some but to make a success of high school training the subjects must be real, live things with which the pupil experiments and which are observed each day by him.

In some colleges the science entrance requirement is not a specific science and all of their courses in science begin with an elementary course. In this way a certain amount of time is lost for those students who repeat the elementary portion of the science which they have taken in school. If this work is well done, and in some schools it is, the engineering college could require physics or chemistry for entrance and begin these subjects at a more advanced place giving an elementary course in physics or chemistry for those who have not had one of them. To require one or the other subject might prevent a pupil from entering an engineering college if the required subjects were not taken and at the time of graduation from the high school circumstances had changed so that a college education were possible although before this time conditions were such that no such plan could have been made.

The work in history has little if any bearing on the actual work of engineering schools although it brings clearly to mind that industrial development is a result of many causes and that the invention of one device may set free a whole nest of possibilities. The steam engine made possible modern industrialism, the gas engine made possible the automobile and the airplane. This training in history gives the pupil a broader outlook on life. It fits him to know more about its development and its significance. History aids us in accounting for customs and methods of today when our complex life is analyzed.

The manual training arts, although of value to the pupil entering industrial or commercial life, are not necessary to the engineering student for entrance as this work in a more philosophical form is done in the college. Those entering the industries may use the high school manual work at once in shop or drafting-room, those in commercial life may utilize this training in their judgment of the work of others. For the engineering student, manual training only gives a more extended experience in such subjects, for in many cases advanced credit can not be given.

From the above it is seen that the curriculum of the high school is satisfactory in general, the great trouble being the absence of intensive drill and emphasis of the underlying principles of the subjects. This same criticism may be made against the college to some extent. The great need of today is to begin the inquisitive line of thought early and at the same time to make the subjects taught real, giving the student indelible pictures by repetition in proof and problem. The gaining of credits, although necessary, is not the important thing, the ability to reason, to judge, to act from the training is the main purpose.

The subject of entrance requirements to our engineering colleges is one which demands special mention. We must have coöperation here between the schools and the colleges. What should the entrance requirements be? This question is answered in many ways by different educators and different faculties. The more advanced the requirement for entrance the greater the amount of engineering specialties which can be given in our colleges. Are these specializations necessary? Is it not the function of the school to give fundamental training on which the specialization is to be developed in postgraduate days? My opinion is that we should give training in fundamentals which can be taught after the average four years high school course. The college may require many special subjects for entrance but in doing so it limits its usefulness. The plea is made that our colleges should have requirements so flexible that the pupil who has done good work in the high school may enter the college on graduation even if college work was not thought of until after graduation. To me the work of the high school should be such that the training in it would fit the graduate for entrance to college, to business or to industry. The age of specialization seems to be crowding out the age of thinking. If it is necessary to have commercial high schools, and manual-training high schools so that the graduates may be self supporting immediately upon graduation, the curriculum of such schools should be so arranged that the necessary mathematics, English, language and science are included and those pursuing such courses can enter our colleges. With specialized college entrance requirements fixing most of the units this would be impossible. Unless the pupil had planned from the beginning to do college work this could not be done if changed conditions made college possible. The engineering school as constituted today stands to receive pupils from a four-year high school course and our requirements should be such that graduates of any good high school can enter regardless of the course they have taken.

The junior college and the acceptance of its work is one of the problems which confronts the engineering schools. The junior college is a development of the last thirty years. This college may take one of many forms. At times it is the name given to the faculty of a university giving the freshman and sophomore years of the present four-year course in which the elementary college mathematics, science, language and history are given and in which the work is preparatory to the work of the university or the professional school. The courses of these years are a continuation of the high school work although done in a more advanced way. The junior college may be a normal school in which work of a college grade is offered in addition to pedagogy. The small denominational college has been urged to confine its work to the subjects of the freshman and sophomore years on account of its limited funds and to improve what is done so that credit may be given by the larger institution which will then carry on the advanced work of the student. The religious instruction aimed at in these denominational schools can be cared for during the two years of residence. Lastly, the junior colleges may be organized in high schools of large cities where the additional expense may be borne. The junior colleges are formed in accordance with rules formed by state laws or by the State University. The rules fix the kind of subjects to be taught in the two years, the kind of teachers to be employed, the amount of work to be done, the pay of such teachers and the kind of instruction to be given.

The reasons for the formation of the junior college are quite varied. They have been formed because of the difficulty of caring for the large enrollments of freshmen and sophomores in some universities. The collegiate preparation for the professional schools has called for two years of work and this can be cared for by these colleges. The junior college in the high school has been demanded by the desire for further education of the pupils, in order to give vocational and finishing courses to those not intending to go to the university, on account of the desire of many parents to keep their children at or near home until more mature, and lastly for financial reasons. The private junior college is usually a denominational college which has realized its inability to give more than two years of a standard college course with the equipment and funds at its disposal.

These colleges are here to stay and as time progresses many of them will be established. What is to be the attitude of the engineering colleges?

The desire of the college of engineering to give the elementary courses of the freshman and sophomore years rests primarily on the feeling that the work in the secondary schools is not done in a thorough manner. Were thorough work done these courses could be given in the junior college. So much depends on the preliminary work in mathematics, physics and chemistry that the lack of thorough training handicaps the student. That the work could be done no one can gainsay.

The junior college with its two year course of general cultural subjects combined with the preparatory course in mathematics, physics and chemistry would be an excellent preparation for the engineering college but on account of the technical work which occurs in the first two years of most engineering curricula the student trained at the junior college can not enter the junior year. These technical subjects do not belong to the junior college nor should they be allowed there. To teach them would be to limit the true purpose of the junior college. This means then that the graduates of the junior college, the Associates in Arts or Science as they are called, require three years to finish the engineering course which is planned to be finished in four years by graduates of the high school. Moreover the first year in residence by the Associates will be a year of mixed work as they are prepared to take subjects of the Junior year of the college and must take some work from the freshman and sophomore years. The arrangement of a special curriculum for them would not be advisable until the number of such men coming to our colleges is greatly increased.

This brings up the question of the five-year course in engineering in which the extra year would be filled with subjects of general science, literature and business methods. A course in languages, including English, mathematics including the calculus, elementary college chemistry, elementary college physics, business law and elementary economics covering two years of a five-year course, where manner more than matter was the prevailing consideration, would give an excellent preparation for the technical and professional work of three years to follow. It would also allow the Associate in Arts or Science to enter the work with juniors of the engineering school and thus proceed with men of the same high school class. The requirement of training in certain subjects mathematics, physics and chemistry should be the same for all graduates of the junior college.

Until all colleges of engineering adopt the five-year course this plan would not be advisable, but it may be that in the immediate years before us the junior college will so develop that the equivalent of the five-year course will come of itself from the large number of associates doing three years of work in the engineering school. It does not seem possible that the engineering curriculum can be changed to permit less than three years for such persons. The endeavor should be made to plan these three years with the minimum of change in the regular course to make a balanced three-years course which would satisfy and attract the associate. Such associates should bring to the college more mature minds and the studies should be grasped more readily and appreciated more fully. They would also bring a culture to the profession for which the need is great. For such the engineering school would be similar to the other professional schools in the requirements of college work for entrance.

The last consideration is the coöperation between the colleges and the consumers of our product: the industries and commerce. Not only do the engineering graduates go into the industries but there is a great demand for men with this training, by sales departments and for the managerial positions of various organizations. What do we owe to those who use our graduates?

In the first place a more complete training in the application of theoretical subjects is needed. Our men should have the theory of thermodynamics but more particularly they should know how to use entropy and variable specific heats; they should know that there is the theorem of three moments but what is more important they should know how to use it and when to use it. In addition to knowing these things and their application we should train them to think. As in the secondary school I feel that we may be criticised in not requiring more thought in our work. We are anxious to cover ground and in our endeavor for this we often diminish the amount of thought training. Finally we should train judgment by selecting problems in which this plays an important part. The results of these problems should be discussed before the class and in this way those deficient in good judgment may receive encouragement and guidance.

The colleges ask the coöperation of industry and commerce in demanding from us only that which we should give and are prepared to give, thinking men of good judgment and confidence, without asking for men prepared for the special activities required in a particular industry. In some cases industry is asking for special courses dealing with a special field. Such things are good as far as they go but in preparing for them the student is deprived of more general courses and the industry is getting a man, assuming he enters this field, who is more productive in the first six months or a year but who would fall behind the broadly trained man after this introductory period.

Industry and commerce should realize that the greatest good comes from breadth of training in the college and special training during the first year or two in the industry. My belief is well illustrated by the way in which the Westinghouse Company and other large electric companies have established the so-called "Test Course" to train men for their own line of work. A representative of the American Telephone and Telegraph Company in applying for men for their plant work stated that what they wanted were men trained to think and reason and that civil engineering or mechanical engineering graduates would suit them as well as men from the electrical course if these were trained men who had acquired that for which the college was instituted. The industries must train men in the minutiæ of their practice. The college should give the basic things of all later engineering work. Our colleges differ in plans of study, some have coöperative courses, some have little or no shop work, yet fundamentally all are working to train students to apply natural laws for the benefit of man and although their graduates start with various handicaps depending on the course they have taken, in a few years these handicaps are overcome and the men are more nearly on the same plane; the thinker, by what ever college course he was trained, at the top. If industry could coöperate in realizing the true function of the college and be willing to do its part in the plan of fitting men to its needs greater things could be accomplished.

The thorough training in the general work of engineering fulfils another requirement of engineering education, that is the preparation of the student for any portion of his field of engineering which may open to him. The preparation for a particular line of work after graduation so often is of little value because of the change in circumstances which renders this line impossible and the graduate must seek another field. A limited man should never be produced. Specialization should come after graduation. The thought of a limited technical school course is open to the same objections which were made to the limited high school course. Our men should be thoroughly grounded in the essentials of engineering. You will pardon my quotation of the motto of Rensselaer, "Knowledge and Thoroughness." This should be our guide in all work.

To summarize the above: coöperation between the schools and colleges is to be obtained by more intensive and thorough work in the preparatory subjects of mathematics, English and the sciences taught in the school, and an acceptance of this work by the colleges so that the average high school can send its graduates to the college without conditions. This latter may mean to some a rearrangement of curricula and this should be done so that graduates from any department of the high school could enter the engineering college. Between the college and industry coöperation will consist in more thorough and intense training by the college in general subjects, the industries assuming the special training required for their peculiar problems. The preparatory school, the college and industry or commerce should realize the limitations, the scope and the requirements of the activities of each other in a broad way and aid in accepting these for their own guidance.

COOPERATION BETWEEN EDUCATION AND INDUSTRY FROM THE VIEWPOINT OF THE MANUFACTURER.

BY ROY D. CHAPIN,

President, Hudson Motor Car Co., Detroit.

Sound engineering education forms the firm foundation-stone of American industry. For this reason I am more than appreciative of the opportunity to talk before your organization about further coöperation between the engineering educators and industrial heads.

Wherein can such coöperation be beneficial to you, your students, and to their future employers? In answering this question, first let us consider the purpose of an engineering education. Primarily it should train the mind to analyze and create, it should provide the student with a means of earning a good livelihood, it should broaden his contact with his fellow man, and as the years go on it should be a potent factor in contributing to the happiness of his existence.

Complaint has been made to me by engineers who have been out of college some years that their profession does not receive the recognition given to that of law or medicine. Their previous training requires an unusual amount of hard work and they have felt the results obtained have not justified their intensive preparation. An analysis of this lack of recognition would seem to indicate that too many so-called engineers have undertaken their profession without any particular fitness for the work. Again, the actual quality of the work of an engineer can perhaps more easily be checked up than that of a lawyer or physician. In other words, his results are placed upon a dollars and cents basis and he is paid accordingly.

The third fundamental reason would seem to be the lack of ability on the part of many engineers throughout their career to make a genuinely practical application of their training. Too often they are not ready for executive work when the opportunity arrives. Business heads are also at fault in employing too cheap or inexperienced engineers for big jobs, then blaming the profession instead of themselves.

INDUSTRY'S RELATION TO ENGINEERING EDUCATION.

Agriculture and industry are the two great businesses of this country. If the success of all industry is founded on sound engineering, then industry has more than a friendly interest in the type of men you turn out. There are so many conspicuous examples of failure of large and small businesses due to bad engineering that you should not have to prove to any executive the importance of his engineering department or the desirability of employing only technical men of the highest quality.

In preparing the material for my talk to you, I felt that one man's ideas could not adequately cover the subject. Therefore, I got in communication with a large number of leaders, particularly in my own industry, many of them executive heads, others engineering heads, but all men of wide experience and usually employers of many engineers. It so happens that the automotive industry is the largest in the United States producing a finished product. It employs engineers in very large numbers, and its engineering methods can certainly be taken as representative. Therefore the suggestions that I may make and the conclusions drawn are founded upon a composite of thought which I hope may be of value to you.

EDUCATION AND INDUSTRY INSUFFICIENTLY COÖRDINATED.

As we all know, there is a great lack of coördination in the present relation of technical schools to industry. Some industries have been wise enough to take advantage of this. They have kept in touch with many of your colleges and have made it easy for your students to find employment in their organizations. Frequently this has not been the best thing for the future of the graduate. The ease with which his first job was gotten has caused many a man to ally himself with a type of work without any particular future and for which he found too late he was not temperamentally fitted. Plenty of engineers who held great promise are still tied down to low salaries even though 10 or 20 years out of college. It seems highly important that graduates should start right, immediately they leave their Alma Mater. We all know the increase in responsibility the minute a man marries, and the tendency that he then has to hold to the work he is doing rather than take the chance on a change which might permit him to go far ahead.

Does not this prove two facts? First, that an attempt should be made to divert men to other college courses who demonstrate they are not fitted to be successful engineers, directing them to those courses to which they seem best suited. Second, that you should give the student the training which will let him become a producer immediately upon graduation and along a line in which he knows positively that he is fitted to work.

Suggestions from Industrial Leaders.

It is a general remark in industry that when the average technical school graduate takes his first job he is inclined to think he "knows it all." He desires too much salary for what he can return to his employer, and becomes impatient if advancement is not very rapid. Speaking from the standpoint of an employer, I have had occasion many times to explain to over-ambitious boys that the only reason for raising pay is because the employe earns more than he is getting, and that to advance, an employe must always be earning more than his pay check indicates. Some employers dislike to take men direct from school and would rather let some other factory give them their first training with the idea that they can then hire them later. Usually men just out of college are paid from 20 per cent. to 50 per cent. more if they have had summer work along the lines of their specialty or have had previous shop experience.

Why should all this be so?

The answer seems to be unanimous that lack of practical training in college necessitates such training after leaving college, thereby holding a graduate back until he has secured a happy combination of both theory and practice. It is impossible to reproduce in your college laboratories or shops the actual conditions within industry. In general the most successful engineers are those in whom there has been developed a commercial instinct which so guides their engineering work that the results pay out. We have had many graduates in our engineering department who, fresh from college, were entrusted with occasional attempts on design work. The results from the new men have been far from satisfactory. Their designs are usually commercially impractical showing insufficient regard for cost of manufacture, length of time involved to bring through the design, availability of the new material specified, or the cost of scrapping the old materials. An additional handicap is that executives are disposed to prejudice the results because they do not conceive the new man to have a sound idea of commercial engineering. Everyone knows that there is a tremendous field to-day in industry for those men who will assume responsibility and who are real executives. The engineer should think outside of his job, should have courage to take responsibility and go ahead. However, to do this he must have a solid foundation of well-rounded training, and it is the consensus of opinion that as yet you men are not furnishing that solid foundation for the average graduate. One well-known and successful engineer has told me that the majority of engineering graduates seem to have acquired the information imparted to them, but only few of them have actually learned to apply that information in practice. The president of a big company says:

"The engineer should have a sufficiently broad conception of the functions of the finance, sales, and production departments and the relationship between them and his own, so that he will have a sympathetic understanding of their problems and difficulties."

Another executive says that

"An engineering graduate in the factory is a liability for some time after his employment."

In talking with young engineers six or eight years out of college, they have regretted their lack of practical experience, felt their progress had been slowed up, and several of them were not optimistic over the future of strictly engineering work. They said that they had no business training and from an executive standpoint they were not confident enough of themselves. Perhaps the answer to this might be that they should have made it a point to secure this training since they left college. Again the human equation enters, and we deal with the tendency of most men to stick to what they call a steady job rather than take chances on what you might term an instructive job.

PRESENT OPPORTUNITIES FOR PRACTICAL TRAINING.

I have investigated to find what opportunities are presented to-day for undergraduates to secure practical experience along their line of study. Of course the summer vacation period has offered the greatest chance. However, the work done is usually without any particular supervision and without an appreciation by the employer of what the boy is heading for. Properly supervised, I believe that credit can well be given for certain work done during summer vacations.

Every executive and engineer with whom I have talked and corresponded is very favorable to coöperative engineering courses between the colleges and industry. All of you are doubtless familiar with these courses at the University of Cincinnati, University of Pittsburgh, the new courses at Harvard, and the coöperation between the General Electric Company and the Massachusetts Institute of Technology. The

University of Detroit has placed a number of men in our factory and many other plants in the city with very successful coöperative results. The men have taken a real interest in their work and the reports from our factory favor such cooperative plan as producing better engineers. Dr. Hollis Godfrey, President of Drexel Institute, has well recognized this need of coöperation and with Dr. Capen is heading a large movement to bring about closer relations between the colleges and the men who employ their graduates. Dr. Godfrey tells me he is meeting with great success in his plan and it merits the heartiest of support.

Essentially you want to turn out men who will reflect the utmost credit upon your institution, upon your ability to teach, and upon the selection of courses that you have taught them. You want to produce engineers who can readily and commercially adapt themselves to the work they undertake. Let me cite an interesting case to you.

How One Famous Engineer Would Educate His Son.

One of the more prominent engineers in the automotive industry is a graduate of a leading university in Europe. During his college course he spent his vacations in various shops acquiring the practical knowledge of the theory which he was studying. When anyone spoke to him about foundry practice he knew what it meant. He had actual experience with steam engines, gasoline engines, operation of machinery, all of this he learned under working shop conditions. When he graduated he planned to go to England to start work. His father advised him to come to this country because of the greater opportunities. To-day his success is acknowledged and he has many engineers under him. He told me that he ascribed part of his success to the fact that coming as a stranger to this country it became necessary for him to study American shop methods and adapt his education to them. This fact was so emphasized in his mind that to-day he feels that he knows the practical side of his work far better than most Americans. From his experience with American engineering graduates he emphatically feels that our colleges should insist upon practical experience that will make our engineers commercial as well as technical. I asked him how he would train his own son whom he hopes will become an engineer? He said that after he graduates from high school he is going to put the boy in a foundry for two months, then in a general machine shop for six months where he will become familiar with a great variety of work, then for four months he will put him in a large plant where progressive manufacturing is conducted on a big scale. As all quantity production in America is now adopting somewhat similar methods, he reasoned that this last experience would be useful for almost any type of manufacturing in which the boy might eventually be involved. He felt that this year of shop experience would quickly demonstrate to his own satisfaction and that of the boy whether engineering work would appeal to him and whether he had a natural fitness for it. He would then put his boy in college with the feeling that he had removed most of the abstract from his college work. The boy would be able mentally to apply most of what he learned in his previous year's experience in actual shop practice. This engineer thought that three years should cover the time his boy would be in school, having given one year of his previous practical training. He would want his boy to spend a certain part of his summer vacations in the shops and perhaps his classes might take various excursions through industrial establishments and receive an insight into the practical methods employed. This is the way that one brainy man would solve the problem of his son's technical education.

APPLICATION OF PRACTICAL METHODS.

Every investigation points to the desirability of practical training. If we are agreed that this is so, how can the colleges best adapt their engineering curricula to meet the needs of the situation. Building up an actual working arrangement with various industries is a slow process for any college.

Some of you have such coöperation now well under way. Others are contemplating it. To those who have not effected such coöperation the time is surely here to make a survey of all industrial possibilities in your section and to interest the industrial leaders in your plan. These leaders are almost always desirous of helping develop education, and are willing to do their share. Those who are slow will be brought into line by the example of others. It is not necessary for me to suggest the type of coöperative arrangement to be worked out as some of your institutions already have ample experience available to you. Investigation seems to indicate that those colleges with coöperative courses are exceedingly popular with the students and particularly with the type of students who realize that their college training is just as much their business in life as their life work will be after graduating.

Faculties Might Well Try It Also.

If this practical up-to-date training in American industry is of value to the student, is it not equally of value to you who instruct the students? Should not you too go out from your college atmosphere and spend a certain amount of time every two years not in consulting work but in actual practical work along the line of your specialty? You would bring new thoughts to the shop, field, or laboratory where you spend this time, and would take back to college with you a more intimate knowledge of just why some of your students make quick progress and others never seem to reach the goal for which their training should fit them. It might prove inconvenient to you but your classes would surely reflect creditably your outside contact.

Other Complementary Courses.

In addition to the practical training, it seems a general opinion that every engineer should be made to take a certain number of courses in business administration, thus furnishing a groundwork for later executive opportunities and a truer aspect as to what is commercial engineering. Everyone with whom I have talked thought this of primary importance. You can confer a favor too upon literary students by offering those students who are going into industry an opportunity by virtue of short courses in the engineering department, to learn how to read a blueprint, and at the same time get some conception of what part engineering plays in all industry. My college experience was confined to literary work with optional courses in law. Actually a better conception of engineering on my part would have made my first years out of college much easier in an industry where engineering plays such an important part. However, a knowledge of the laws pertaining to patents and contracts is valuable to all business men and particularly to the engineering profession.

Highway and Automotive Engineering Openings.

Automotive engineering is now so ramified and calls for so many men that I am sure your institutions will do well to keenly study its future. Outside of mechanical, chemical, electrical and metallurgical engineering are now the newer great developments coming in highway, traffic transport, and safety engineering. Incidentally automotive engineers should always have some training in highway engineering that they may appreciate the relation between their product and the roadbed it traverses. Enormous appropriations are being made for highway construction in this country and at a conference in Washington this spring called by Dr. Claxton, of the Bureau of Education, it was quite apparent that the demand for highway engineers as well as highway transport engineers is already far in excess of the facilities of the colleges of the country to turn them out. I am sure that the automotive industry will gladly coöperate in any of your plans looking to specialization in automotive subjects.

Two Ideas Regarding Research Work.

One other point that seems to be of interest to the men with whom I have talked. They feel that great results can be accomplished in your research work and methods. Perhaps quotations from some of them will interest you. A well-known engineer says:

"I am strongly in favor of a certain kind of research for seniors—a sort of easy research with practical application that will not present problems so hard as to discourage the man who is working on them, and yet difficult enough to give him a sense of accomplishment in overcoming the obstacles that arise, and different enough from his ordinary work to catch his interest at a time when a good many men begin to go stale. Research work of a different type, more difficult, and perhaps more theoretical in nature is justified in postgraduate courses and as subjects for faculties to work on. Such work increases the prestige of the school, and extends the fund of basic knowledge on which all our practical commercial structures rest. At the same time, the men in charge of all the engineering courses should have enough practical experience to know what are the desirable factors to make prominent in the minds of their men in order to build up the habit of thought and a perspective that will increase the chance for each student becoming a real success."

One executive says:

"I believe that research conducted by the higher schools of learning is often lost to the commercial world because of the fact that the investigators do not have the commercial instinct nor do they always realize the value of the various results which they obtain when practically applied."

Another suggested that engineering colleges should have the opportunity of comparing their research results with those of the industrial laboratories to the benefit of both. He thought that the Bureau of Standards or the National Research Council might well coördinate research reports from all technical colleges, thus preventing too much duplication, and at the same time encourage efforts in needed directions.

In conclusion it seems quite apparent that more practical training must be given as part of the engineering courses and that it is most desirable that the professors and instructors should actually know by personal experience what this practical training constitutes. America is entering a period of enormous industrial expansion and with her rapidly growing export trade our engineering methods are fast coming in competition with those of the European engineers. It is your natural desire to lead the world, and this is best expressed in the quality of work turned out by the men you graduate. Give these men during their college course a more practical insight into the everyday problems they will encounter after graduation, even though it takes you some years to build up the practical contacts necessary. Thus you will secure for your graduates the respect and admiration of those who employ them and the same respect and admiration for your recognition of their problems.

A PLAN FOR COÖPERATION BETWEEN THE COLLEGES AND INDUSTRY.

BY S. P. CAPEN,

American Council on Education, Washington, D. C.

Ladies, and gentlemen, I did not have the good fortune to see a program before arriving at this meeting, and I was not exactly certain what it was I was to talk about. I understand I am to present to you, and it will be very briefly, an outline of the plan for general coöperation between industry and the colleges, which was first formally discussed at the meeting of the Technology Clubs Associated, in Philadelphia, March 26. The same purpose underlies the plan which has animated various individuals and groups and institutions for the last three or four years, namely, the desire to take some kind of measures which would look toward remedying the appalling shortage which now exists in the supply of highly trained technical men. This association, through the work of individuals, and through the work of its committees, has been to the fore in this movement. The plan I am to discuss represents merely an attempt to extend the movement and to bring about concerted action between the principal institutions of the country and industrial concerns located in the vicinity of each.

The plan has had a long period of incubation. A great many persons have been associated in it first and last, but, as your president has suggested, the stimulus was applied by President Godfrey, of Drexel Institute, and I presume he is more responsible for it than any one else. Before I begin to discuss the details of it, I might briefly remind you of certain facts which justify any reasonable effort to bring about closer relations between the colleges and industry.

There never was a period when the supply of trained men was as short as it is now. We had some experience with a threatened shortage during the war. A number of you gentlemen were engaged in the investigations made at that time with a view preventing a shortage. We all feared that the country would lack expert personnel to carry on the war enterprises. We fortunately escaped a famine during the war, but we are evidently in the midst of a famine now. There are evidently several factors that condition it. In the first place, a great many men who were trained technically, were either killed or wounded in the war, or else, because of their experience in war operations, have changed their jobs and have been lost to productive enterprises. As you know, also, there has been an almost complete stoppage of immigration during the last five years. The majority of the persons this country secured through immigration was not of the type I refer to, but there was still a considerable number of men competent to occupy more or less responsible positions, who came here as immigrants. That supply has stopped. And the supply of trained material that was coming annually from the colleges up to the year 1915 has been suddenly cut in half. The drop in the output of the colleges has been anywhere from forty to fifty per cent. At the same time the demands upon American facilities for production are greater than they ever were before. There is a larger domestic demand, and evidently the foreign demand is not only greater at present, but is likely to be increasingly greater as time goes on. Hence we have to meet a situation in production which calls for the most intense effort and we face it with a reduced staff.

Figures were presented at the conference in Philadelphia to indicate that the shortage was most acute in men who occupied managerial and executive positions. Naturally the shortage at that point is most seriously felt because without the skilled managerial officer, the operatives count for less.

Also it was brought out that industrial management is gradually becoming a special profession. The training for it thus far has been very largely empirical, but it may be systemized and through coöperative action between colleges and industry, the time occupied in producing a person skilled in the various phases of management may be shortened.

Now, it was the immediate purpose of the plan that was endorsed by that meeting to bring these facts to the attention of the colleges generally, and to devise, if possible, a method to assist institutions, each one in its own locality, to coöperate with industrial undertakings in the most effective way. The problem evidently has both national and local aspects. The conference was primarily concerned with the national aspects of it.

Each large industry, I am told, has already organized or may easily organize within itself a committee or a group or an office or a bureau which studies the needs of the industry and is able to specify the number of trained men who may be needed in various types of positions through a period of years, and which is able also to define the kinds of jobs that various men in executive positions will have to perform. There were present at the conference in Philadelphia representatives of several industries which already had organizations of this kind. I recall, for example, that the representative of the paper industry said it would be possible for that industry to give a very accurate figure of the needs for the next five years in men to occupy executive positions.

The fundamental features of the training for different industries are evidently similar. Viewing the problem, therefore, from the national point of view, as a national undertaking, there appear to be three things that are particularly desirable. The first is that each large industry shall consider its training problems with reference to the industry as a whole, and not exclusively with reference to the needs of a particular industrial plant. A few industries, as I have just stated, are already doing that. In the second place, it was judged by the conference to be desirable that each industry should realize the educational and training needs of other industries. And, thirdly, those who are concerned with the preparation of training programs for the industries should have constant contacts with the technical schools and with other types of colleges, in order that the colleges and the industries together may determine their respective parts of a systematic course of training.

A phrase was used at that meeting, which I confess was new to me and at first not clear; very likely to this company it is perfectly clear,—the phrase "joint specification of the educational product." As it was interpreted in the course of the discussion, it meant that the schools and industry should have constant consultation with each other, industry specifying what it needed, what it believed it could itself furnish in the way of training, and the schools, on the other hand, specifying what they thought they could put into a joint training program. These conclusions that I have just cited emerged from the discussion of the conference, and from the meetings of the committee which preceded the formal conference session. They determined the form of the plan that was proposed.

Very briefly the plan is this: It provides machinery for the study of the educational needs of industry, and for periodic consultations between the representatives of industries and representatives of educational institutions. The conference believed that there already existed an organization which represented different types of educational interests, the American Council of Education, of which this association is a member, and of which I happen just now to be director. There was some discussion as to whether it was appropriate that the coördinating body should be this society, the Society for the Promotion of Engineering Education. I judge that the reason for the decision not to ask this society to furnish the coöperating group was because it was hoped to draw into the scheme a large number of arts, colleges and other types of institutions, not primarily technical. The industrial representatives who were present, very much to my surprise, stated that they expected that they could use the art college graduates quite as freely as technical graduates, and that coöperative plans which involved the joint contribution of arts colleges and industries should be worked out. The American Council on Education contains, as I said a moment ago, the representatives of various kinds of educational institutions, and it was felt that the Council could best act for the educational interests in this matter. The Council was asked to coöperate.

No similar organization exists in industry. Perhaps none ever could exist. There were at this conference, I think, some twelve different industries represented, large industries, like the paper industry, the boot and shoe industry, paints and oils, railroads, and so on. It was proposed, therefore, that as a first step, each one of these industries should by action of its central body, appoint a delegate to a central industrial council which would roughly correspond in organization to the American Council on Education. I think that the title that was suggested for this council was the Council on the Management of Education. The functions of that Council would be, as far as was foreseen, three: First, to determine the needs of industry for men of the management type, second, to define the kinds of jobs which they would be called upon to perform, and third, to develop opportunities locally for coöperation between industry and the colleges.

It was decided that when this Council on Management Education should be established, there should be appointed a small joint committee consisting of five representatives of the Council on Management Education and five from the American Council on Education, which should perform the following tasks: First, the Committees to define for the use of the industries and of the Council on Management Education, the kinds of specifications of product that are useable and intelligible to educational institutions, that fit into a college organization. It was reported that many of the demands that are made by industry for training are unpractical because they apparently take no cognizance of the kind of organization which exists in a university or college, and of the limitations imposed by the basic purpose of academic institutions. Secondly, this joint committee is to review the specifications submitted by industry, and criticize them. Thirdly, it is to circulate them with comment among the different types of educational institutions.

The Council on Management Education is in the throes of organization, I understand. Some eight large industries have already appointed their delegates to it. It is an operation that takes time. The industries have to be approached at the time of the meetings of their central bodies. I believe that none that has been approached thus far has refused to join. The Council Management Education will be ready shortly to start operations.

The American Council on Education felt that this was an undertaking in which the engineering schools and this society were primarily interested. It has already appointed its committee of five to serve coöperatively with the industrial committee. You may recall that you, as an association, have three representatives in the American Council on Education. We have taken the two of these who happen to live within more or less easy reach of New York and Washington as members of this committee of five. The two are Dean Bishop and Dr. Mann; Dean Bishop is Chairman of the Committee. The other members are the president of the Association of American Colleges, President Ferry, of Hamilton College. and one of the representatives in the American Council of the Association of Urban Universities, President Kolbe of the University of Akron. The fifth member is myself, not because it was judged that I had any particular fitness for the task, but because under the constitution of the Council the Director has to be on all committees.

Now, there are one or two general observations which I might make in conclusion. The first is that this plan is still tentative. A great many people have already been consulted about it. But criticism is still welcomed. The plan embodies the well tried principle which many of you are operating on already, the principle of coöperation between an institution and industry, and, as I said in the beginning, the only desire of its promoters is to spread the principle still further and to use it to meet larger national emergencies. It is not intended to supplant anything that already exists, but to enlarge and enforce a well established movement.

I am sorry, gentlemen, that I did not have time to prepare a formal paper for you. I hope you will excuse the somewhat disheveled character of these brief remarks.

DISCUSSION.

John Airey: Mr. President, ladies and gentlemen: We have listened to a very interesting paper on the necessity for coöperation between engineering education and industry. In fact, it seems to me that the joint authorship is a good example of that coöperation, on the one hand we have a leader in industry, and on the other hand a leader in education. In the large field of engineering education, I doubt if there is any topic quite so important as coöperation with the industries, because the existence of our engineering colleges has actually been caused by industrial requirements interpreted in the broadest sense.

We need coöperation primarily for two reasons, first, in order to insure that our continuous stream of graduates is directed in those channels in which they will be most efficient, that is, from the standpoint of national economy. Secondly, we need coöperation in order to insure that we, in the educational institutions, keep sufficiently in touch with the problems of industry, problems of a type which industry cannot be expected to solve for itself.

I would like to draw attention to one example where I think coöperation is distinctly lacking. Over a period of years in munition work, one thought constantly recurred to me until it became a conviction. This thought is that the almost entire absence of college graduates in the strictly production departments of our manufacturing establishments is distinctly to be blamed upon our system of education.

In the "engineering department" which concerns itself merely with the design of the article to be produced, we find college graduates fairly plentiful, but in the strictly production departments, they are almost none existent. I have noticed this commented upon by a good many people. Now, what are the reasons? I can think of three: First, our curriculum at present is too intensely technical, and we have too little economics. Secondly, if we had addresses on orientation to upper class men, I think considerable change might be effected. The average graduate does not realize the possibilities in production. If he were offered a job as assistant foreman at an hourly rate, the chances are nineteen out of twenty, he would refuse it, although he would have greater opportunity ahead of him than in the strictly engineering department. If we had a few addresses given by representatives of industry as an aid to orientation I think considerable change could be effected. At least, it is likely, if the real facts regarding scope and possibilities of advancement in strictly production work could be got clearly before students that a large share of our graduate students would be diverted into strictly production lines. If we are to keep a reasonable balance at least one third of our graduating classes should now be going into production and side-stepping the more restricted so-called engineering department.

A third reason why a student does not take to production lines is our inadequate shop work curriculum. Mass production has developed roughly in this last quarter of a century. The shop work in our universities is almost everywhere still on the old basis of teaching those principles needed in the making of things in twenty-fives, or hundreds, whereas in mass production the methods and conditions are entirely different and call for entirely different ideas, different systems, different methods of organization and so forth. Now, if our college shops were changed so as to make them into laboratories for production, by so doing, the student would realize that the production department has scope in it which he otherwise would not recognize from his too technical viewpoint. I might say, in this connection the Board of Regents of the University of Michigan has permitted us to begin the manufacture of a small article for which we have a market to the extent of four hundred per day. That means a real mass production proposition, and we can make the shops into a production laboratory. Further, we can invite the Economics Department to use our shops as a laboratory in connection with their courses in organization and accounting. By so doing, it is my belief that a good many of our students, who otherwise would feel that to go into production would be *infra dig* would find their future outlook considerably changed by it. We probably all realize that some graduates after having been out several years in the so-called engineering department drift into production, but we should not let them wait four or five years. I think I see signs of changes all over the country in this direction; and doubtlessly in another five years this condition will be much more apparent.

To come to the second subdivision, that is, research, the same criticism holds good. In the strictly engineering department,—I am using the term "engineering" in the narrow factory sense of designing; the use of the term is really open to criticism; we engineers would like to think of engineering as something broader than mere designing, but in every factory the term is so used. In the strictly engineering lines, no matter whether it is steam engine, turbine, gas engine, or even gas turbine, considerable research has been done and is being done at present. Turn to the shop processes which we meet in production and see how they stand from a research standpoint. It is true the fundamental action of the lathe has been fairly well covered. The milling cutter industry in this country is at least something like twenty-five to thirty million dollars per year. Milling cutters today are being made according to a design strongly influenced by a tradition because they happened to have originated centuries ago as a rotary file involving a scraping rather than a true cutting action. That condition exists because of a lack of coöperation between our educational institutions and our machine shops. That example could be multiplied many fold.

There is just one other example I would like to draw attention to. In the machine shop there is probably no topic looked upon as so essentially empirical as that of machining tolerances. Every manufacturer knows the importance of machining tolerance and their ability to make or break a contract. Up to two or three years ago nearly everybody believed this subject to be wholly empirical. Now, I am convinced, and I think some other people have the same idea, that the whole question of machine shop tolerance can be.put on absolutely rational basis. It is connected up with rather difficult mathematics. I suggest to our mathematical members that there is enough work in this line of research to keep them all busy for the next five years. Furthermore, it is impossible to calculate the benefits from a standpoint of national economy; it would have to be measured in tens of millions of dollars every year. If the mathematical theory of probability were taken as a basis, I think a most enduring and valuable structure could be built. It would, however, call for first-team work between shop engineers and mathematicians.

Lastly, on the question of coöperation, how often do we hear the remark, "It is all right in theory, but in won't do in practice." That really is a reflection on coöperation. If it is all right in practice, it is all right in theory. Eventually when Utopia arrives and we shall have perfect coöperation presumably this statement will never be heard. A step toward this condition has been made, let us hope, by the papers of Mr. Chapin and Dr. Capen. I think that one of the most valuable pieces of work can be done by this society is to endeavor to build a a good sound bridge, and yet sufficiently flexible, between our educational institutions and the industries.

E. A. Fessenden: At the Pennsylvania State College we have realized the importance of proper coöperation and coördination with the industries and we have also realized the difficulties that operate against institutions located in rural communities in securing this coöperation and coördination. In an attempt to solve some of the problems involved in a location where "close-up" coöperation, alternating week or month plans, etc., are entirely impracticable we recently invited a conference of representatives from a number of industries who are in the habit of employing our graduates, to meet with our own faculty heads to discuss the question of how we, as an individual institution, could best tie in with typical industries. The number of men engaged in this conference was kept small, and as a result we were able to get into close, individual touch with each other. We invited these men to look us over, examine our equipment and buildings, ask us questions and criticize us freely, and to tell us frankly ways in which they thought we might improve our methods and our product. They did so, quite freely in many instances, though they did not criticize nearly so severely as we expected they might.

One of the points brought out early in this conference was that engineering education has gotten away from academic educational ideals and that most engineering education today is really a high type of vocational training. The boy comes to the engineering school in order later to be able to fill a certain kind of a job. In general, his advance ideas as to the requirements for that job are extremely hazy, but notwithstanding this, attempts at vocational guidance, at least in our experience, are not very successful. As an example, may I recount our experience last fall? Every freshman entering the School of Engineering was interviewed by at least one of a group of men who were supposed to be able to ferret out some of his peculiarities and to guide him in a broad way into the work for which he seemed best adapted. We did this in a measure as self-protection, because the School of Engineering was becoming crowded and there were more applicants than we could properly accommodate. I interviewed about ninety freshmen in mechanical engineering; as I recall it, I advised about twenty-five per cent. of these boys to try something else. Of those so advised I have yet to hear of one acting upon the advice.

Some of the topics discussed at this little conference might interest this body.. In our rural location we must depend upon summer work for actual contact of the student with industry. Our requirements for graduation make it necessary that every student receiving an engineering degree must do a certain amount of work of an engineering character during his college course. This work is done during the summer vacation and the requirements are such that more than one summer's employment is necessary. In general, it is somewhat difficult for these boys to secure employment, for the summer only, which will give them really good experience. We asked the industrial representative whether something could not be done to organize the summer work much more efficiently and thus make it more valuable to the student. They agreed to take up the question seriously in an effort to meet the point named. The difficulty is, obviously, the cost to the industries of handling a large influx of transient and green labor. Suggestions to permit summer work done during the college course to be credited as a part of the time required in the special apprenticeship courses maintained by a number of the larger industries were well received. A very liberal attitude was held by several of the men, expressed in about these words by one of them, "In my industry, we do not care if we do spend a dollar in training a boy one summer and fail to get it back because the boy does not like our work and leaves us to go into some other industry the next summer or at the close of his college course so that the other industry reaps the returns from our dollar. Some other industry will spend a dollar on another boy who will ultimately come to us so that we receive the return on their investment in that boy. These will all balance up in the end."

The question of the proper summer employment for teachers of engineering is being seriously considered by a number of the labor industries. In too many cases, summer work for teachers is routine drudgery, poorly paid, with little responsibility and little value as experience. It is definitely realized that a very large opportunity is presented here if the work is made interesting and attractive and of real value as education and experience to the teacher. The value of the industries is both direct and indirect if the work is properly chosen, as for example, investigations and computations connected with development work where the special standards of the routine work of the organization are not continually involved. The industrial representatives at our conference agreed that much of real value both to the industries and to the institutions could be secured by the proper use of engineering teachers during vacation periods and promised to have the matter carefully considered by their own companies.

It was the unanimous opinion that highly specialized education should not be attempted by the engineering schools. The industries want men trained in "the fundamentals," mathematics, chemistry, physics, business practices, economics, English. Most of the industrial representatives stated that they did not particularly care whether an engineering graduate whom they were to employ had taken the course in electrical engineering or mechanical engineering or civil engineering. They are interested in whether the student is guided into and trained in right methods of thinking rather than in the specific subjects taught. They agreed that the engineer must at some time become a specialist, but were most emphatic in their belief that the college was not the place for this specialization. The men from the industries expressed the idea that the industries themselves must be responsible for specialized engineering education and that it is not the business of the engineering schools.

Altogether, we felt that our little conference was very successful. I want to leave as a suggestion to the other institutions here represented that similar conferences will unquestionably be of value if only to serve to secure better acquaintance between the colleges and the industries in such a way that each will realize and appreciate something of the requirements and the limitations of the other. Such conferences should be kept small so as not to lose the intimacy of association necessary for the best results.

F. C. Caldwell: Mr. President, there is one phase of the subject of coöperation that I do not remember to have heard touched upon in any of our meetings, and that is the part which the industries might take in supplying the engineering college with the right kind of students. We have just heard a few moments ago that we should send a third of our product into production, whereas now we are sending almost none. We know that every year the field for the employment of engineers becomes broader and broader. We need an ever increasing number of men. At the same time, we are feeling that we ought to more carefully select the men we are to train for engineers.

Now, one of the things which industry might be persuaded to do, and it would require some persuasion, is to take definite and organized steps towards picking out from their forces men who are of the right kind of material to make engineers, and to encourage them to go to college, for the engineering courses. The only case of that sort that has come to my attention, although there are doubtless others, is that of the Westinghouse Electric & Manufacturing Company, which now has definite scholarships, open to its own employees and to sons of employees. These scholarships enable them to go to any college they choose. Now, whether that is the best way to carry out the plan, I do not pretend to say, but it does seem that this is one of the things that industries ought undertake. There certainly must be many men who have got started in the shops, but who would make good engineers; naturally, however, being good workmen, their foreman do not want to lose them, and the tendency is not to send them away to school, but to hold them in the shops where they are making good. I feel that such a movement is one of the things that we can use our influence to bring about.

In regard to the general proposition of coöperation in the way of student work, during their summers, or through regular periods, this seems to be coming to be the usual thing. At the Ohio State University we have in the Electrical Engineering Course men taking a supervised required summer course, for the first time this year. Two other departments have provided for it, and I do not think it will be long before it is required of all our engineering graduates.

W. E. Mott: Mr. President, in this connection, I would refer to an experiment the Carnegie Institute of Technology is making this year, which we hope will contribute something to this general question. In common with many other engineering schools, for a number of years we have conducted the usual type of course in mining engineering, but we have never been able to attract many students to the course, although we are situated in a district where coal mining is one of our major industries. Following the suggestion of certain operators, we have transformed our regular four year mining engineering course from one which prepares mainly for designing work, to one which emphasizes operation and superintendance. We have formed an advisory committee, made up of about six representatives from the industry, both owners and operators, the local vice-president of the Miners' Federation, the Chief State Mine Inspector, Mr. Holbrook, recently superintendent of the Pittsburgh Station U. S. Bureau of Mines, and others, including the head of our department of Mining Engineering, Professor Crabtree, and our coöperator, Captain Steidle. This committee has laid out the new curriculum and, most important of all, is advising not only as the subject we should teach, but also is keeping in close touch with the students. The companies have sent us a number of men and have urged others, to take up this course in mining. We have as many Sophomores as we can handle this year. Many of these men are older than the average student and are financed by the companies themselves. We thus are in active, close coöperation with the industry and the United States Bureau of Mines, whose Pittsburgh Station is next door to us, and where our students may study and attend lectures given by the experts of the Bureau. We hope that this experiment will strengthen and revivify our work in mining engineering.

We offer also a special two year course in Mining, and the number is limited to about twenty students per year. The men taking this course have grown up in the mines, many of them married men, who have taken this opportunity to obtain instruction in the fundamentals of engineering. They already know the practical mining work. The trouble is to hold those students. Some have left us this year, after only a few months additional study, at salaries which certainly are interesting to a college professor. I think this two-year course gives greater promise as a coöperative measure than the four-year course.

Our third experiment is a four weeks summer course for men in the mining industry who wish to become inspectors and fire bosses.

We feel that the active and earnest coöperation of the men who are in the industry as well as the State and U. S. officials who are responsible for carrying out government regulations, insures the success of this experiment in coöperative work.

F. W. Sperr: I don't know that I would have come forward, Mr. President, but for the question I had in mind when the last speaker was on the floor, and I would say as a teacher of mining, that I am very much interested in just what would be involved in teaching mining engineering students, mine operating, and I hope that this matter may be amplified for the benefit of all of us. I must say that to my mind it might involve many different lines of work, and just what specifically would be indicated is not clear to me.

Our Committee on Mining will be especially interested in this matter, I am sure, and I would like to have it further explained at an early time, if possible.

Louis Brand: Professor Airey's remarks on milling machines reminded me of a specific example of coöperation between industry and education that came to my notice a few days ago. The University of Cincinnati has coöperated for the last ten years with one of the large milling machine companies in Cincinnati, and at present a number of executive positions in that organization are held by Cincinnati graduates. A large number of coöperative students are placed in this plant. Now, when a student has learned to operate a milling machine with a fair degree of personal safety, he often thinks that he knows all about it and rapidly begins to lose interest in the work. Just at this point something must be done. So the engineers and the foremen of the milling machine company and the staff of coördinators at the University have compiled a pamphlet of about twenty pages dealing with the milling machine and its problems. This pamphlet contains over a hundred questions on the milling machine, classified as follows: types of milling machines; miling cutters—shapes, characteristics, and uses; fastening of cutters; speed and feeds; milling operations; the spiral head —Indexing and spiral milling; data required in the design of a milling machine; data required in the milling machine department; some of the forman's problems.

These questions will probably occupy many an off moment of the student; and it is not improbable that some of the problems suggested will ultimately lead to improvements in the design of the milling machine. I should add that the questions on machine design and on forman's problems, assigned to the student by his coördinator, require written answers.

Plans are under way to compile similar pamphlets for the various machines used in the plants of coöperating firms.

W. G. Raymond: Mr. President, I am not quite sure whether the industries or the schools are on trial. One or the other must be. I am reminded that a good many years ago, none of the industries wanted any college trained men. They said, "We want a man who comes up through the shops and knows all about it. The other fellow is only a theorist." Now, they come and stretch out their hands to our graduates and beg them to come into the shops, to come into the drafting room, whether we have had coöperation or not, and the reason is, I suppose, that they have learned that the man who is trained to think, whether he has had that particular job in mind or not, is the fellow who is worth while in their enterprise. You all noticed Mr. Chapin when he came to the platform and spoke, and those of you who did not know him, or had not known him before, thought he was a man who had arrived at a pretty young age. He confessed that he had not had any engineering training at all. He is the head of a great manufacturing industry. He was trained in arts, and then he went into a shop. It was not coöperative. I have no quarrel with coöperation in engineering training. It means—doesn't it?—that the boy who goes into engineering in that sort of a way does pretty much the same thing as the boy who goes out of high school into the dry goods store, the garage or grocery shop, something of that sort, he just works all the year at the job. Part of the year he studies, part of the year he works at something that will earn him a little money maybe, and give him some further experience. Now, more of the young fellows who go into engineering would do that same thing, it doubtless is a good thing,—if the industry would provide him with a means of earning some money so that he could go to school the rest of the year. About half, maybe, nearly half of the students in our school are in whole or in part self-supporting; they have to work during the summer, and if some industry would provide them with as much money as a summer resort will give them for running a launch, or waiting table, or something of that sort, they would go into the shop; they would not go to the summer resort. As I say, I am not sure quite whether it is the school or the industry that is on trial.

I am very glad to hear one thing said, I think from the University of Pennsylvania—from the State College of Pennsylvania—that is, it does not make any difference whether the fellow is trained as a civil engineer, mechanical engineer, or what not. Evidently the industrial managers at that conference wanted a man who has been trained to think, rather than a man trained to do some specific job. That is what we are trying to provide. We have gone a step farther than most of the schools, I think, at our place. I heard Dean Cooley say this morning that he had known in the past twenty-seven or thirty years of the existence of this institution, of this society, of a good many researches being made, but he never heard of the results of one being put into practice. I want to tell him of one.

Quite a number of years ago I was chairman of a committee on graduation requirements that we created after we had heard a good deal about entrance requirements, and I made as much of an investigation and research as I could by inquiry of practicing engineers in all lines, as to what they thought the schools ought to do, and almost with one accord, excepting a few fanatics, who would teach in four years about what ought to require ten years, they said, "Simply teach the fundamentals, we will do the rest after we get the boy. Just about that time I was moved from my former position out to Iowa where I was given the privilege of formulating a course in engineering, and I formulated a course in engineering based on that research. It has been operating very well since, I think, but we have gone a step farther. We have alrealy realized, without calling a conference, that what is needed is simply men who are trained to think, men who are trained in all the fundamentals of engineering, if possible, and so we have changed our course, so that our courses in mechanical, civil and electrical engineering are alike until the fourth year. We would not differentiate them if we did not think we had to go on conducting an engineering school. We would go on and give the men the fundamentals for four years, and then if they wanted to specialize in a school course of some kind they could, but if not, they might specialize in any one of the departments of engineering they might be called upon to practice according as opportunity might offer.

E. H. Rockwell: Mr. Chairman, we have been hearing from the mechanical engineers, and one might judge that the only engineer is a mechanical engineer, or one might judge that the only engineering was electrical engineering. I represent civil engineering in my institution, and that fact makes me think of a story which you will pardon, perhaps. This is supposed to have occurred in the vicinity of Boston, but it might have occurred anywhere.

A few people were visiting an asylum for the insane, and the guide was one of the inmates. They proceeded until they had come to the cage where one of the violent inmates was held, and the guide, one of the inmates, says, "This man thinks he is God, but he is not." He says, "I am." And then the visitor said, "This is a unique experience, the first time we have ever come into the presence of the Almighty. We wish you would tell us the answer to a question we have been worrying about." I do not remember the question, but it might have been this, "Who will be the Democratic Nominee for Presidency?" The inmate was not so far out but he replied, he never talked shop while he was taking visitors around the institution.

Now, the point I wanted to make is simply this, that those who are interested in civil engineering, think that it is one of the important branches of engineering, and the question arises just where that sort of engineering comes in in this matter of coöperation. Personally, I have some ideas to the effect that the colleges of engineering, as far as the civil engineering department is concerned, must set the pace as far as many of the theoretical questions are concerned. I think of an omnipresent critic who writes for the Engineering Record every week or two, who has been telling us about common sense, and he wishes to discard all theory, all higher theory, in the colleges, and substitute common sense. If that is the sort of advice that the civil engineering departments would get from the industries, I, for one, would be loath to accept it. I think that the civil engineer, at least, is in a somewhat unique position in this matter of coöperation. I have not very many ideas to express today, because I am not convinced as yet that coöperation is entirely advisable in that course at all. I think I agree with what Dean Raymond has said, that the college should teach men to think and approach problems, and solve them after they go into practice.

C. G. Brown: Mr. Chairman, I was very much interested in Mr. Chapin's suggestion in regard to early contact between the student and the industries, and my views coincide with his in that he did not make any definite point whether that should be between high school and college or in the early part of his college course or a little later, or just where. It certainly is a very important point, and our school has seen to it that the students in the collegiate department have a great deal of such contact with the industries.

Another point that also coincide is the contact with business relationships. In other words, there should be brought to the mind of the student the fact that business, as business, is something that he should be vitally interested in. I know that in my own college course I had very little opportunity to understand the relation of various engineering bodies to business. Now, that those points are being adapted so universally in the thought of prominent leaders, it seems to me those ideas are going to grow, and that before many years those ideas are going to develop and produce much closer coöperation in those respects.

There is another point that I would like to emphasize, and it is not merely because our school is bringing it to pass, in the collegiate department, but it is because it has been my thought for some time. Just to illustrate, there seems to be a change in many of the high schools. The high schools were setting higher and higher standards for their graduates, and it was necessary for the student to specialize almost from his freshman year if he wanted to be a high school graduate that could enter a technical college. Now, we are finding more leeway. Why? The answer seems to be that it is the duty of the high schools to educate not merely the small percentage that are going to gradute and go through college; it is their duty to spend their efforts on the students that come to the high schools, many of whom are going to college, and an enormously larger number of whom are not going to college. Now, in the engineering schools, and as has been brought out here, and as is always being mentioned, many of the students are not suitable to go ahead and graduate as engineers. They do not have the qualifications; and they do not show the ability. And even though when you advise them that they ought to take some different line of work, again, as has been pointed out, they do not change their course, at least very few of them change it, until they are notified their standing is so low that they are required to drop it.

Now, why could we not do more by giving the student during the freshman year such courses that he will have something he can use, if he has to leave college to go to work? In other words, instead of spending the time on purely preparatory courses for one or two years, courses which are preparatory in the sense that a man is getting very little for practical application, why not let him have such courses as are necessary in mathematics and in English, and also bring in some of the elementary engineering work? Many students, for financial reasons, as well as other reasons, find it necessary to leave at the end of, say, one year. If such a student has a little elementary engineering work, which is of such a nature that he can use it, then he has received a benefit, which it seems to me he does not receive if he has only the abstract courses, or those that seem to him abstract. Incidentally, it makes this difference too, that the student, instead of feeling all the time, "Why do you give me this subject in mathematics, why this subject more advanced? Why, it is for more advanced than I will ever use." Instead he is using his courses in mathematics and other lines soon after he takes them, and that makes them interesting to him, and he can see the value, just as has been pointed out, and can see the value of his course. There is less of an abstract field to it if he can have practical work even before he has any of the college work. Certainly he should have it during his college course, if he cannot have it before.

P. F. Walker: Mr. Chairman, there are two or three points which I would like to mention in connection with the discussion. The question has been raised as to why industries might not, if they do not, send occasional students from their working groups,—I say students, meaning those who are in the student courses of the industries,—to the regular engineering schools for more complete training. As to the possibilities for that, I might cite an instance of an arrangement between the University of Kansas and the Santa Fe Railroad Shop Training school organization. Mr. Thomas, of that organization, did send one or two students to us. There are certain difficulties which stand in the way of this, however. One is that usually thos boys who are with industries are not fitted as to entrance requirements; their school training has not been as to enable them to enter the regular courses.

While speaking of the railroad, I wish to mention one other point. Happily, the present instance has passed, but we may run against the same proposition again. It is this: During the war, during the time when the railroads were under government administration, there was a contract made with the unions, which made it absolutely impossible for any engineering graduate of a regular technical school to get into the line, that is, into the operating departments of the railroads. That sounds astounding perhaps to those who have not been aware of the situation. That period is over, but I am not well enough informed as to the present situation to be able to say whether or not under present conditions, or under conditions that are likely to obtain under the new railway administration act, any difficulty of that sore will be continued, but I do say, gentlemen, that the time may be coming when it will be necessary for this organization, as well as some others, to take into account certain vital factors in industry which touch very closely this matter of the participation of our graduates in industries.

I want to say with reference to the comments on mining work, that I am intensely interested. In the mining work at the university with which I am connected, we have had in mind and have partially worked out, a system similar to that which Director Mott has outlined. Therefore, I heard with a great deal of interest the report of the committee on mining, together with the comment which Director Mott has made.

I hope I will be pardoned if I inject just this point, a new thought into this matter of coöperation. I will have to do it by citing as an illustration the process by which some of us are endeavoring to work out a certain kind of coöperation in the West. I happen to be Chairman of the Research Committee of the mid-continent section of the American Society of Mechanical Engineers. We are endeavoring there to determine what work is going on in that great industry which occupies that region primarily, that is the petroleum industry. Methods by which work is being done there are being brought under a form of supervision or direction, and at the same time being coördinated with the agencies in the territory that are particularly well equipped with research apparatus. The work is just beginning, but this much has been done. We are to have at our institutions a man next year, a young man as a graduate student on part time, who will give half of his time, at least, to the careful study of a problem which is of particular interest to the oil refiners. That young man this summer is working with one of the largest oil refiners in Tulsa and is there under an arrangement with the company for the express purpose of making it possible for him to get thoroughly in touch with the actual problems that he will be attempting to solve in research work. Not only that, but I have arrangements made with this company whereby, as soon as he has progressed to a point where he feels that he has a sort of preparatory foundation, he may go to that plant and have made available, immediately and directly for his experimentation, full size operating equipment operated with all the skill of the regular employes in the refinery, in order that he may test his results in the laboratory of actual practice.

I speak of those points to illustrate what may be called a system of coöperation between industries and our educational institutions in that field of research, and I believe that it is a matter which deserves our attention, Mr. Chairman, just as thoroughly and heartily as that of fitting boys to go directly into the employ of those companies.

J. R. Allen: For a great many years the Society of Heating and Ventilating Engineers have realized that it was necessary to know more about the fundamental laws underlying their problems and to have further knowledge in regard to the application of these laws in actual practice. In order to study these laws more carefully, the Society established a Research Bureau in connection with the Bureau of Mines at Pittsburgh.

The object of this Bureau is not to deal with commercial tests but with fundamental problems of the industry such as problems of best transmission and a study of the fundamental principles of ventilation. After studying the field of heating research we very soon realized that it was very desirable to know what agencies were conducting work along these lines and what character of experiments were now being made. In order to do this, visits have been made to most of the universities and research laboratories of this country to find out what the present status of research work in heating and ventilation is.

The Subjects Committee of the Research Bureau, after studying the situation, concluded that there were three principal functions of the Research Bureau:

First: The collection of all available information on the subject of research in connection with heating and ventilation.

Second: Devising of standard methods for the use of the Society.

Third: The conducting of actual research work. This research work is divided into two groups; research to be done at the Bureau of Mines; and research work to be done at other locations.

The research work outside of the Bureau of Mines is largely being done at the universities. The Society has allotted certain funds that can be used for stimulating work in the universities. At present, experiments are being made at the University of Minnesota, University of Michigan, Pennsylvania State College, and we expect very shortly to coöperate with other institutions along these lines. This coöperation between a national society and the universities seems very desirable. It accomplishes two purposes. First, it strengthens the bond of relationship between the national organizations and the universities, and secondly, it familiarizes the schools with the actual problems that engineers are studying; and brings to the school a lively interest in the engineers' problems. We have already published two papers as a result of this coöperative work. This coöperative work between the universities and the commercial organizations can be still further stimulated to the advantage of both parties. Some of the larger corporations are already considering coöperative work with the universities similar to that carried on by the American Society of Heating and Ventilating Engineers.

The American Society of Heating and Ventilating Engineers have one great advantage in this coöperative work and that is that their efforts are confined to rather narrow lines of specialization and they have very definite problems to work out. We have laid out a series of problems which we hope to assign to about a dozen institutions so that we can rapidly solve some of the most perplexing problems that have been presented to the Society.

I hope that other national societies may in the future see their way to make a similar arrangement with the various universities.

R. D. Chapin: As you can well imagine, it has been very illuminating to me to listen to the discussion which has taken place. I have endeavored in my talk today to speak from the standpoint of the executive, not with engineering education. I have tried to make my talk applicable to other industries as well as the motor car business. In going into the subject of coöperation in detail, I have had an opportunity to investigate the matter of coöperation in various institutions. I was very much surprised to find we had some students in our own factory from a local university. These students were doing very good work. Similarly, in Detroit there are other students in other institutions, and going beyond the mechanical side of it, they are at work with electrical concerns, with chemical concerns, and they are out doing service work for railroads. It is rather interesting to note that they are presumed to bring somewhat of a trained mind to their work, and it gives them a wage which is going to enable them to go right straight through their college course with the money they have earned, without any outside resources. It is a well known fact, gentlemen, that among the best students you graduate are the men who earn their own way through college. It does furnish a way to finance them through, and you are not only training them to be men, but you help a great many men to go through college and secure a technical education who would otherwise not have it.

You are suffering, I know, in practically every one of your institutions from a flood of students. All of you probably have more students than you can properly take care of. The funds being raised around this country to increase the salaries of the faculties of the colleges are evidence of the fact that colleges ought to have more support. It seems to me that if you would start your students in industry some monthse before they come to you, you are going to weed out your students very quickly. Those students you have advised not to take up engineering are going to speedily find when they have to go out and make a showing in the shop whether they are liable to stick to engineering or not, whether they will honestly like it.

The point has been made that there is a responsibility on industry. There is no doubt about that. Industry has not properly appreciated that fact. Industry, as is usually the case, will usually answer, "We have troubles enough to our own."

Now, at the same time, industry, I think, is approaching its problems in a much more intelligent way than before. You will often find educational departments instituted in large factories. They are endeavoring to solve the problem of bringing in some of their men and getting them trained along some line that will help the factory itself. The work Dr. Capen has explained to you is a very strong movement in the right direction. Giving specifications for industry is going to be a help to the industry, will make the men think on the job. It is going to make them think a little better, make them analyze the available openings, and see whether their organization is properly framed up. In addition, it is bound to help you, because it is going to give you the coöperation of industries. Every one of us wants to attain to the highest quality of work he can. Teaching is as much a business as anything else, and there is nothing in which new methods are any more needed due to the fact that the requirements are so different than fifteen or twenty years ago. I want to assure of my confidence that in your coöperation with industry, as explained by the speaker today, you are going to get a much warmer coöperation than perhaps you expect. Industry today means a great deal more than making money, and in its relation, both to its men and to the world in general, as well as in looking at things in their higher aspect, I think you will find your coöperation most welcome.

I thank you very much for the opportunity of having appeared before you.

ENGINEERING SOCIETIES AND ENGINEERING EDUCATION.

BY IRA N. HOLLIS

President, Worcester Polytechnic Institute.

This paper has grown out of certain reflections on the relation of engineering societies to the training of men who will ultimately enter the profession and thus become eligible to membership. The subject is not limited to the establishment of student branches or affiliated societies of engineering at the universities. It has a much larger aspect. Up to this time, no engineering society has fulfilled its possibility in relation to the training for the profession. It is doubtful even if any society has done its full duty. Certainly none has ever taken advantage of a real opportunity in this period of changing education, changing ideals and changing methods in the industries.

Broadly speaking there are three ways of getting into the engineering profession.

1. As in the early part of the nineteenth century by apprenticeship and experience. It was called the school of "hard knocks" and if there had been an engineering profession previous to 1825, that would have been the school. Through apprenticeship to some master was the natural road to all of the occupations that subsequently developed into professions.

2. By graduation from a technical school or the engineering department of a university.

3. By training and education in the industry or through some other channel after leaving the ordinary public schools.

A satisfactory classification would be most difficult as every individual is more or less a law unto himself and he may have had part in all three of these methods of becoming an engineer. In fact, before studying relations of societies to education, it will be useful to know how these societies are made up. The percentage of men becoming engineers through apprenticeship is growing less and less as the methods of engineering have crystallized into more and more a scientific tabulation through research and experiment. The older mechanical engineers will remember that in the early '70s there were few books on their profession and the science was largely empirical.

Our Societies are made up as follows:

	Civil Engineers.	Mining Engineers.	Mechanical Engineers.	Electrical Engineers.
Honorary members	3	15	9	6
Members	4,050	7,072	6,036	1,617
Associate members	4,789		2,360	
Junior members	492		2,791	
Associates	167	621	687	9,224
Junior associates		787		
Fellows	10			498
Corresponding members	1			
Total	9,512	8,495	11,883	11,345
Estimated percentage graduated from college	80%	80%	50%	50%

This is not intended to be exhaustive of all engineering societies in the United States and the figures are correct only up to April of this year. The four that are here mentioned have always had the education of their members as a principal function. This has been necessarily true and it has served to build up our profession into a real one. The exchange of papers on the applications of science, the meetings for discussion, the consultation amongst members on special subjects, and in general the coöperation of engineers in these societies for the information of the public and for enabling members to do their work better, is all educational. When the societies depart from that field into the more controversial subjects related to politics and government, they will cease to be of great value as engineering societies. Furthermore, if their principal function ever becomes that of employment agencies for engineers or that of a union to increase salaries, they will surrender their most useful function, namely, to enable engineers to deserve more by the better service that they can render. These societies have a natural alliance with educational institutions and they form the postgraduate courses for all engineers, every man of whom ought to belong to one of them. This does not mean that engineers ought not to take an interest in politics or in the many problems connected with government; in fact, it is a very good thing for local sections to be formed or for local engineering societies to discuss local needs. It has long been thought that the profession would be better off with one large engineering society split up into professional or geographical sections. That may be a sound theory but taking by and large the experience of the world, the engineers are really better served by close association with men who are occupied in the same field. As a matter of fact, one large engineering society would probably lack much of the educational value of the present professional societies and the country might stand to lose more than it would gain by the larger influence over government possessed through one great society. The only reason for considering this aspect of the case in this place relates to the influence that engineering societies may have over education and the place that these societies may occupy in assisting students to fit themselves better for their professions.

Another question: while engineering has been defined, no society has apparently ever defined for its own use those who constitute the engineering profession. We know that the man who makes use of materials and forces of nature for doing man's work, especially on a commercial scale, is an engineer. What name will describe the man who directs the work of the man who makes use of the materials and forces of nature? That has never been well studied out as shown by the kind of membership offered by our societies.

In the Army, there are certain prejudices in favor of West

Point and we think of a West Pointer as a soldier, just as we think of the graduate from a technical school as an engineer, but the West Pointer who has completed a four year course is not the only soldier to fight. The majority of our officers during the World War came from civil occupations and became soldiers in a relatively short time. Many of our successful generals have not graduated from West Point and many of our officers have entered from the ranks without ever having gone to any school excepting their own home schools when they were boys. Is a graduate from an engineering school the only professional engineer when so many thousands enter the industries by the other two roads? Our membership is constituted on lines that would make one think so. The definitions are entirely too technical and we have therefore resorted to division into grades. It is necessary only to speak of one of them because societies are more or less alike. In the Mechanical Engineers there are:

1. The man who is an engineer or teacher of thirty-two years of age. He must have been in the active practice of his profession for at least ten years and in responsible charge for five. He must be qualified to design and to direct engineering work.

2. The Associate, who does not have to be an engineer, but he must have been connected with some branch of engineering or science or the arts or industries such that he shall be qualified to coöperate with engineers.

3. The Associate Member who is essentially the same as a member with less professional experience.

4. The Junior who is an engineer because he is capable of filling a subordinate position in engineering work.

When we talk about a man who is qualified to coöperate with engineers in the advancement of professional knowledge, do we mean a man who is at the head of a great engineering establishment, who directs the work of engineers? Our whole modern classification is bad in that regard. Any man who is managing a great industrial organization involving large masses of men in manufacture or transportation is essentially an engineer or he ought to be. If he has treated himself as an executive who deals only with high finance, he may have gotten by with his job, but he has usually made an awful mess of the thing for someone who succeeds him. One of the great mistakes of modern times is the separation of manufacture into too many departments. As a matter of fact, every man who is employed in an industry should have had at least some engineering training at the bottom of it. There is too often an engineering department set off against the management and other things, with the thought that an education through science and engineering is needed only for the strictly technical man who expects to lean over a drafting board the bulk of his life. The methods of engineering schools are in truth at the foundation of all departments of industries and transportation and the men at the head of these departments are essentially engineers. This does not mean that a young man who graduates from a technical school is by that fact an executive. It does mean, however, that he is well trained to begin any department of manufacture.

We all know too many examples of successful management through experience to have any illusions about the advantage of a college education. Undoubtedly on the average, the years spent in higher education will enable men to grasp more quickly the larger problems before our country, but the successful men are not confined to college graduates. The old and commonly accepted belief that colleges of liberal arts offered the only broad and sufficient preparation for executive positions is simply stuff. A member of the Massachusetts Institute of Technology Corporation once told me that the M. I. T. was an excellent training for men to occupy subordinate routine positions and that Harvard was the place to produce executives and managers. In the real everyday experience that is not true at all. The universities of this country have turned out too many men from the colleges of liberal arts who have mismanaged more than they have managed.

Our definition should classify as an engineer within our profession every man who has learned how to manage a great business involving the use of power and materials. That is what he is. Examples without number can be quoted to establish this and I am tempted to give one as far from the ordinary track as can be imagined. The president of one of our great engineering companies began life as a salesman and bookkeeper in a shoe store where he spent about three years. He had graduated from the high school in one of our smaller cities. As he has told me, after the shoe store went into liquidation, he drifted until he became a clerk in the freight office of a railroad where he stayed for one year. One day, by accident, a friend asked his father where he could find a bookkeeper to help him out in some work that he had undertaken. He was glad to take the job and he remained bookkeeper for a few years, then secretary, then treasurer, and now president of one of the most progressive engineering firms in the United States. What is he, a shoe dealer or an engineer? We in the A. S. M. E. have elected him as an associate of the society, capable of coöperating with engineers. This seems to me more or less absurd. He is an engineer and an honor to our profession.

We are on the wrong basis just as the country is and we cannot maintain it. The education of business men who are going into manufacture or transportation is found through engineering defined in its broadest sense. The many examples of the delay that bad classification has created may be found in the gradual evolution of America. Many years ago the Navy of the United States was organized on the same false system as most of our industries. It was stated openly by the deck officers that the officer in command of the ship was an executive who did not need to know details like the propelling and auxiliary machinery of the ship for which he was responsible. This is too often the idea of the members of great companies and it is certainly at the root of the inefficiency of our government. A memorial was once sent to Congress signed by the majority of the deck officers of the Navy stating that engineers were essentially civilians who could be hired at any time. A more rotten circular never was prepared by unenlightened men and it accomplished nothing except to expose the prejudice and small minds of the signers who had learned their profession in a sailing marine, but nevertheless, twenty years passed by before Congress took the business in hand and cured the strife between line and staff of the Navy by fusing line and engineers into one corps, the groundwork of whose training was engineering. As President Roosevelt wrote in one of his messages, "the future naval officer will be a fighting engineer." It was fortunate for us that we had as President one who saw so clearly. His prophecy has come true, for the commanding officers of our destroyers in the war zone were all engineers, or at least brought forward through a school of engineering. That is all the Naval Academy is to-day.

Congress cannot deal with the country as it could with the Navy and therefore by legislation it cannot train the managers of our industries and transportation into business engineers which they are. The world will have to do that when it gets rid of the old type and understands better the functions of an executive at the head of a great industrial corporation. It may not be necessary that the man at the head shall have been educated in college, but it will be necessary for him to learn the methods and ideals of the engineering profession in order to do his work best so that we may have in the near future a new type of executives.

In discussing this aspect of manufacture with bankers and business men, I have had this statement vigorously denied. Men who have nearly wrecked our industries are those who contend hardest for the freedom of the individual, just as the very men who go into politics are unwilling to make real professional requirements unto the art of government. A new species must come along for we have lost faith in those who in their pride have set up a kind of feudal system. The executives or the heads of big business have come by pressure into more enlightened methods and they do not yet realize that in the management of men they have often been failures.

We have never even understood the word prosperity. It does not mean the exploitation of nature's resources and the robbery of future generations. When we export more coal and raw materials than any other nation, we are simply reducing our potentiality in the future. Prosperity is measured by the frugality and moderation and the industry of a nation rather than by the luxury and show. Conservation combined with efficiency offers the only road to the right kind of prosperity wherein no one man and no one board of directors has control over the lives of other men. We cannot change our country by legislative enactment, but we can change it by educating our citizens to the truth and the professional training most capable of giving our larger executives an intelligent understanding of democracy. Heretofore the engineering societies have shamed themselves by consenting to occupy the subordinate place of technically educated men who have no capacity for executive management. The world will never recover from its present unrighteous haste until we shall have accomplished two things. First, human sympathy through the precepts of Christ. Second, the proper use of materials and power through training in the fundamentals of engineering.

Very few people realize the importance of power to modern civilization. In the United States, for instance, at least nine tenths of the work is done by mechanical energy. At the end of the Revolutionary War it was done by man, or by man with the assistance of a few horses, but now it is supplied by the combustion of coal, by the development of our water-power, and even by the use of the wind. With more than nine tenths of our work done by machinery, what are we coming to unless the fundamental education of the world takes note of that fact and through the right kind of training informs its students just what the use of fuel on a great scale means to the future? The coal dealer knows nothing about the waste of coal, nor the miner, although his executive manager may have graduated from the mining school.

What are the engineering societies going to do about all this? Are we going to stand before the open door of opportunity and wait for another generation to mess things up? We cannot, we must not. The life and wellbeing of all this nation are far more dependent upon us than upon any other class. Let us only direct our attention that way and our men will educate themselves after leaving college. One of the greatest mistakes made by a great body of men in our profession is that they are educated for the profession by graduating from a technical college and that men cannot learn anything not begun in college. While there are happy exceptions to this fallacious idea, nevertheless our profession is more or less unprogressive in taking up new phases of life in America that really belong to the engineering profession. Mr. Taylor gave us the germ of real efficiency in our manufactures but he went no further than man as a machine. He taught us little about the effect of engineering education upon the general business of our country, or the effect of his system upon the individual.

While the membership of engineering societies is made up largely of graduates from the engineering departments of universities or from technical schools in which engineering is taught as a profession, we must remember that the whole attitude of men in transportation and the industries has changed. There is a cordiality towards the college man that did not exist twenty years ago, but it is not clear that the engineering graduate has succeeded in demonstrating his high qualifications for much outside of the drafting room and the technical routine. There are many examples of individuals graduated from engineering schools who have proven their capacity for high places, but the average of the rank and file still has much to learn. The world is in desperate need of executives who have been trained for their work and who have an intelligent understanding of something more than the technicalities of their business and their profession.

What shall this new training become and how far are the colleges procuring it? It is often stated that the most valuable qualities coming out of a college are character and breadth. The common mistake, however, is in treating these qualities as peculiarly a college product. As a matter of fact what we need most is men to do the work of this country and that is the first duty of every engineering school. The word "character" is very loosely used and it applies to the law schools and medical schools and to every other school just as much as it applies to technical schools. It is perfect folly to generalize on character as the principal thing for the engineering profession. It is the principal thing for everything. The word "breadth" is also used very vaguely. Necessarily if a young man is going into the industries he should have a clear understanding of the tendency of the times and a better understanding of the ideals of his own country. A boy learns breadth at his mother's knee. It certainly means human understanding and sympathy with the needs of other people. Ordinarily the colleges when they discuss breadth apply it to an all-around knowledge of literature and science, a knowledge which amounts to nothing without the human sympathy which enables men to deal justly and fairly with the human problems in all our national activities. An advantage gained from college is contact with one's equals. That alone will do more for students than most of the education to be found in the classrooms where the breadth is usually lacking.

And yet there is a necessity of keeping our engineering schools up to the times and they need the help and influence of engineering societies towards that end. We rarely give back to the schools from which we graduated the result of our experience as related to the course of studies. Most criticism is flippant or ill-considered. Graduates customarily complain that what they studied is either useless or had no bearing upon the problems of life.

When the Society for the Promotion of Engineering Education was formed, it had a definite goal in view. Its new members hoped it might become an important influence towards unifying and standardizing the methods of technical education and that it might also tend to introduce a certain outlook upon the profession that would help to lift the standing of engineering graduates. It has served a useful purpose but it has never formulated any program under which all engineering societies could work together to serve education in some form. A few years ago, through this society, a committee representing the civil, mechanical, electrical and mining engineers was appointed to bring in a report on the education of engineers but their work was a failure until the Carnegie Foundation was called into consultation. It seems discreditable as we look back to think that our societies in coöperation with the Society for the Promotion of Engineering Education could not produce a good report on the preparation of their own men for their own profession.

The purpose of this paper is to offer to our membership an opportunity for discussing the function of societies in education and the best method of making them useful to educational institution. Part of the futility of such relations in the past has been as much due to the college as to the engineering societies. No good way seems to have been generally adopted for giving students the time to benefit by contact with engineering societies, to obtain the outlook that older men might be able to give them. The years have brought many changes and one of those changes is the very general recognition by educators that while students may not have the time for intimate study of the industrial life of a nation, they should at least have some glimpse of their opportunities. Most of the larger societies have encouraged the organization of student branches and to some extent this movement has succeeded.

While this is not a paper on education, it will do no harm to state very briefly what the graduate of an engineering school should carry away from his alma mater.

1. In the first place, he should have had a first-rate knowledge of the fundamentals that underlie his profession. That would include English, usually badly written by young engineers; mathematics, rarely understood or in practical use beyond trigonometry; and the physical sciences not sufficiently

emphasized in the ordinary four-year courses. Foreign languages are not usually understood at all. It is doubtful if they really serve any highly useful purpose. This sounds like heresy and yet if the time given to German and French were put into English, especially into the practical and proper presentation of all subjects that are studied at college, we should be much better off as a profession. The old idea that the study of modern language is enlightening and broadening is a pleasing illusion as the languages have been taught in the United States. Few students ever get much beyond the grammar and none ever get to the point of speaking a foreign language through study in the United States. There is a common thought that calculus is like a dose of medicine which must be taken to cure the patient but is of no use afterwards. As a matter of fact, calculus is the concept through which we learn the mechanics at the base of all engineering and students ought to be required to know the subject better as the chief foundation on which their profession rests. I know that many practical engineers have done good work without a knowledge of calculus. Some of their work has lasted for centuries. At the same time we are considering here the education of thousands of average men who are not geniuses, often not even talented, into useful members of our profession. What applies to the natural born engineer does not at all apply to them. Too much cannot be said about the writing of English. Most of us feel more or less cramped through a certain lack of power to express accurately our thoughts and we have few or no books on engineering that are well written.

2. The second element in the education of an engineer is necessarily made up of technical or professional subjects. Often these are mixed in with the fundamentals. For instance, when we study the applications of mechanics, we usually study at the same time, the mathematics of mechanics and we apply the methods to technical design and construction. It is not necessary to dwell on this part of the engineers' training, as we all know about it. If we have any fault at

all, it is in overdoing the information side, and in yielding too much to fads.

3. This third aspect of the engineer's experience at school is rarely much considered and yet it may become relatively important. It is the side of the school curriculum on which the engineering societies may have most influence. It might be called glimpses into the future. It is like running through a book to show a student what he ought to study for graduation; to indicate what are likely to be the developments in his country, especially along industrial lines. A student takes economics and he has not the time to get more than a few principles, but he can have his attention directed to economics in industry and can learn that economics usually involve vastly more than what is ordinarily found in books. There is the human problem, the health problem, the wage problem, the hour problem, all as applied to the development of each man as an individual. It is only necessary to direct the student's attention and to interest him in continuing his education after graduation along lines that will reconcile the conflicting forces in modern industries. It might be well to name all those subjects that relate to an engineer's life after graduation, the extras of his education. They can possibly be omitted in college but they must ultimately be learned if our profession is to fulfill its highest function in modern civilization.

There is a constant temptation to modify the courses in engineering schools in accordance with the ideas of certain advocates of reform, but it is doubtful if any good substitute has yet been put forward for four years in the fundamentals of engineering and in enough of the technical branches to begin to learn the profession after graduation. The extras that have been referred to can never be learned in college and it is extremely doubtful if the student ought to be subjected to the fads of teachers who do not agree on what the modern education of a boy should be. We know that there is such a thing as human engineering and we, as members of engineering societies, can direct attention to it, but no teacher can make that a major subject in his course without harm to the schedule of studies. We know also that there is such a thing as safety engineering, but all that we can hope to do in a four-year course is to stretch the mind of the student in such a way as to enable him to take in the necessity for safety and the safety appliances commonly used, without any course of study on them. Here again, I am not proposing to raise a discussion on systems of education, but rather to emphasize the necessity of adding a number of proposed subjects only as "frills" in the hope that the engineering societies may assist in the right way.

The question to be asked is: How are the societies to do their share? All of them ought to take part in the education of men who enter their professions. I cite only one. The American Society of Mechanical Engineers has student branches amongst students in those colleges having substantial departments of mechanical engineering. The following report has come out of numerous meetings of a committee now called "The Committee on Relations with Colleges." I sent synopses to some of the college in order to invite criticism, and the whole matter is placed here for discussion on the part of our society.

To the Honorable Council of the A. S. M. E.

Gentlemen: Your Committee on Relations with Colleges begs to submit the following report and recommendations:

The ineffectiveness of our relations with colleges seems due to lack of a definite program, a failure in coördination between the parent Society and the student branches, and a resultant reliance upon the initiative of a few individuals whose interest fluctuates from year to year.

While nothing should be done to disturb the present autonomy of the student branches we would recommend an addition to the By-Laws as follows:

> Each student branch shall annually elect one of its members to serve as Corresponding Secretary. He may receive a nominal remuneration and expense account from the Society. His duties shall be those ordinarily attached to such a position and in addition thereto he shall be responsible for the maintenance of records and serve as channel of communication with the parent Society.

In this way there will be established a tangible official connection through which suggestions from the Society may be made leading toward continuity of policy and interest. In pursuance of this plan a further addition to the By-Laws as follows would be desirable:

The Society shall issue every spring a syllabus or suggestion of some one subject or subjects, for consideration for the following year.

It is understood that this is to be done merely by way of helpful advice or guidance and involves no element of dictation, but on the contrary that individual initiative on the part of the branches is to be vigorously encouraged.

At present the activities of the student branches—while no two colleges have exactly the same methods—may be grouped under the following heads:

1. To get outside lecturers on technical subjects.
2. To get outside lecturers on non-technical subjects.
3. To get salesmen or agents from manufacturers to describe their product, usually illustrating with a stereopticon.
4. To obtain lecturers on general subjects from members of the general faculty with which the engineering department is connected.
5. To encourage students to speak on their feet in public meetings (*a*) by giving them the periodicals and books to be reviewed orally; (*b*) by having the results of theses, investigations, and technical work conducted by the student, described; (*c*) by the delivery of brief addresses on non-technical subjects.
6. To broaden the contact with engineering by joint meetings with other branches of engineering in the student engineering society.
7. To bring students together, mainly for social purposes and for making them acquainted with A. S. M. E. and its usefulness to them personally.
8. To teach them initiative by non-interference in the student branches, thus leaving to them all activities outside the classroom.

These are all to be commended. By way, however, of a suggested list of topics (such as contemplated under the proposed By-Law) the following may be enumerated as well worthy today of consideration by a student branch.

1. The general effect of the Peace Conference and the League of Nations upon the work of the engineer, especially in commercial life of the nation during the next generation.

2. The method by which war disorganizes industries and the work of reconstruction that invariably follows every war. The general reconstruction that must follow this war in all the belligerent countries.

3. Standardization for manufacture and the effect of this war in forcing engineers and manufacturers to reduce the number of parts and

to simplify construction of all kinds of machines. Standardization for guns and munitions.

4. Conservation of national resources including fuel, water, soil, forests and minerals.

5. Labor and the complete readjustment of society in order that employer and employee may live together in peace. Examples of the solution of problems in different manufacturing companies.

6. The problems of transportation, national and private ownership, and the changes consequent upon improvements and rapidity of transportation.

In the judgment of your committee it is advisable that time for the activities of the student branch should be taken from the present demands upon the student so that they may not become of the nature of additional courses of study and that credit may or may not be given in accordance with the conditions that prevail in each college. Recognition should in all cases come from the parent Society since this will foster closeness of relationship. It may take the form of an extension of the present system of Student Prizes such as Certificates of Award, for those papers which merit recognition, even though they fail to win one of the prizes. Gift or loan scholarships may also be provided. The details of this would require knowledge of the funds available and could be worked out by the committee for later recommendation to the Council if the general idea meets with approval.

The Committee submits herewith certain recommendations for consideration and approval of the Council. It may be wise to specify that in approving these resolutions both the Council and the Committee regard them as a tentative method of working out our relations with the education of men for our profession, to be modified and extended as experience proves their effectiveness toward the purpose in view.

1. An addition to the By-Laws as follows:

> Each student branch shall annually elect one of its members to serve as Corresponding Secretary. He may receive a nominal remuneration and expense account from the Society. His duties shall be those ordinarily attached to such a position and in addition thereto he shall be responsible for the maintenance of records and serve as channel of communication with the parent Society.

2. An addition to the By-Laws as follows:

> The Society shall issue every spring a syllabus or suggestion of some object or subjects for consideration for the following year.

3. The authorization of ten scholarships, not to exceed $200.00 each, to be awarded under rules prepared and administered by the Committee on Relations with Colleges.

4. The setting aside of a fund to be invested in loans for deserving students, to be administered by the Committee.

5. The authorization of the necessary expense for sending a representative of the Society to visit student branches, preferaby selecting one or more members of the Committee on Relations with Colleges for this service.

6. That the Committee on Relations with Colleges be instructed to encourage coöperation among the different branches of engineering in college as well as among the different student branches in the different colleges.

7. That the Committee on Relations with Colleges be instructed to encourage the students to conduct the affairs of the branch themselves rather than to depend solely upon faculty direction or supervision.

8. That the President of the Society either personally or through the Committee, be requested to confer with the Engineering Societies, looking to cooperative effort in connection with education.

9. That the Local Sections of the Society be requested to interest themselves in the student branches within their localities.

10. That the organization of student branches be left with the Committee on Relations with Colleges subject to the approval of the Council.

11. That, so far as it seems advisable and possible, the Society, through its committee, assist the student branches in obtaining from time to time a few good lecturers from the outside.

12. That a student who has done the most effective work in a student branch in his senior year may be elected to junior membership in the Society upon graduation by the student branch, and that the Society remit the Initiation Fee and dues for the first year.

13. That the present system of Student Prizes be continued, and, if found possible and advisable, extended.

Ira N. Hollis,
John R. Allen,
Joseph W. Roe,
William B. Gregory,
Guido H. Marx.

This report went before the council and has been modified to enable the society to carry out some of its suggestions, but as a whole, it has seemed too heavy a proposition. Take the case of a syllabus, which might become important. That has not been done at all and I think it might well be taken up by the Society for the Promotion of Engineering Education, the syllabus to contain a number of questions and titles that graduates from engineering schools ought to understand. Many of them can be studied very well by the students themselves without much guidance from their teachers.

The principal question raised here is whether the schools ought to be more definite in setting apart hours for study and discussion relating to the outlook of engineering and its connection with the industries after young men graduate. I have written the following letter to a few teachers and I am inserting their replies in the hope that they may benefit others as well as they have benefited me.

WORCESTER POLYTECHNIC INSTITUTE,
WORCESTER, MASSACHUSETTS,
April 8, 1920.

My dear Sir: I have begun the preparation of a paper to be presented at the next meeting of the Society for the Promotion of Engineering Education. It relates to the hours given to Student Branches of Engineering Societies entirely outside of the regular schedule, or, in some cases, forming part of the regular schedule as stated in the college catalogs. We might call these extra hours seminar hours. I find a great difference of practice and I am bringing the whole matter up before the Society in order to arouse discussion as to the value of such hours. Will you not write for me something that can be published in the Society transactions as to the practice in your place? In general, the questions I am trying to answer in my own paper are as follows:

1. Should an engineering college encourage regular meetings of student engineering societies?
2. Should the hours given to such meetings be added to the schedule of studies or should they be part of the schedule, time being allowed out of the lessons and preparation devoted to the regular work?
3. It has been suggested in a number of places that the topics taken up in the meeting hours should be entirely outside of the classroom subjects. Is this the practice in your place?
4. Should such meetings be conducted entirely by the students or through the help of professors and outsiders?
5. How far have commercial firms been encouraged to send representatives to such meetings.

I have no wish to confine you to these questions. My only hope is in bringing about a better understanding among engineering colleges as to the best method of introducing technical students to the larger questions relating to the industries and business.

This matter has been considered by a Committee of the American Society of Mechanical Engineers, but I hope that it may be extended to all national engineering societies and may be useful in the promotion of a fine broad education for all men who are going into our profession.

I am hoping very much that we may have an interesting conference on Student Societies at the next annual meeting of the S. P. E. E. There is no one term to designate the hours for these meetings. I have called them seminar hours but that is somewhat awkward as the word "seminar" may lead to a confusion of ideas at different universities.

Please do not feel that you have to limit yourself in your reply.

Yours very truly,

I leave this letter for the consideration of other members of our society. It was quite impossible for me to communicate with all of them. Of one thing I am definitely certain and that is, in all colleges not enough is made of, first, the value of correct expression and, second, the knowledge of what the engineering profession opens up to its members. Every college ought to have its hour, at least once a week, set apart for the extras and it ought to be carried out in some systematic way. If the engineering societies of the country could only unite enough to support a small Bureau of Education with its lectures and teachers for general service throughout the country, they could be of inestimable benefit to engineering.

These societies have a real duty to assist in making a better profession and better membership. It can be done only by beginning in the schools. The principal difficulty with our Student Branches is that they have no really satisfactory contact with the societies and they are more or less inert. Their vitality fluctuates from year to year and their value to the students averages very low except when they are stimulated by professors who take an interest. Last year the A. S. M. E. found it expedient to revise its Committee on Student Branches and to change the name to the Committee on Relations with Colleges. This was done from a high sense of duty and there was some correspondence with the Society for the Promotion of Engineering Education. A committee of our society was appointed, consisting of

C. L. Mees, *Chairman,* Rose Poly. Inst.,
A. B. McDaniel, Union College,
W. S. Rodman, University of Virginia,
E. A. Fessenden, Penna. State College,
L. M. Defoe, University of Missouri,

to coöperate, but on account of great pressure and other things, no meetings were held. The success of any plan depends largely upon the attitude of mind of the faculties, how far they permit students to give their time to discussions and to work under the influence of American societies. After an extended correspondence with the engineering schools, it is quite evident that practice varies somewhat. Shall work or activities of Student Branches have recognition as part of the work towards a degree, at the expense of sacrificing to some extent the technical courses? The average time required for an engineering schedule is in the neighborhood of fifty hours a week, including recitations, lectures, laboratories and preparation. Should the hours given to student discussion be included in this fifty hours? It is in some colleges; it is not in others, and opinion varies. The hours turned over to students for discussion either with or without their professors might well be called "seminar hours" such as we find in the large universities for economics, history and other subjects. They might be utilized by small groups of students, or by Student Branches, or by the students as a whole.

While the A. S. M. E. may do some good through its branches, the whole subject of student engineering societies ought to be taken up by the Society for the Promotion of Engineering Education through a fairly comprehensive committee. This society ought to make an effort to bring about a substantial agreement amongst all the engineering societies towards the exercise of some function on their part to assist young graduates into better contact with their profession. I repeat this is not intended to be a reform in education or a replacement of fundamental courses by "frills," but rather a larger outlook on engineering through the meetings of students and the coöperation of the societies towards making those meetings really fruitful.

In answering the question, what is the good of student branches of any engineering societies, one might say that there is very little good if confined to generalizations. I have visited many colleges and I believe that not enough is made of student discussions. The lectures commonly brought in from the outside are often in the air and they do not afford any great amount of stimulus. A number of letters which I am appending will show fairly well the practice in other colleges. They are well worth publication for the benefit of this society and some synopses may be made. The important thing is a larger committee to consider this whole question of extras and perhaps of reforms in our system of education.

March 30, 1920.

Accompanying please find response to your questionnaire of March 6th together with a few suggestions.

1. Yes.

2. If the number of hours exceeds 52 per week, laboratory recitation and preparation—3 hrs. laboratory equalling 1 recitation. Extra hours should not be added to the schedule. 50 to 52 hrs. per week seems a sufficiently heavy schedule of work for the best results.

3. If possible attendance upon meeting of "Engineering Societies" should not be made compulsory, a part of the regular schedule. Some method of giving credit to students, other than the required credits, should be devised for those who by attending these meetings show a desire to broaden their education and evince a live interest in their work and a disposition to benefit as much as possible from the opportunities offered.

4. It certainly is desirable to do this. Every department in Engineering, especially the Economics department, may properly give some time to the discussion of related problems. If the time equivalent of one lecture per week be taken from the regular scheduled hours of four or five departments the loss of time from the regular exercises in each department will be very small. A definite programme of subjects, etc., should be prepared in conference between the heads of departments, subjects selected and assigned to the department where they can be best treated and the work coördinated. These forming a part of the regular exercise would be compulsory and credited in the ordinary manner. Members of Engineering Societies should suggest definite subjects to colleges for such a programme.

5. In general subjects prepared at student meetings should be presented and discussed by them. As far as possible students should have the management of these meetings. Professors will be needed in an advisory capacity and will probably have to take part in the discussions to direct them into proper channels and stimulate them. It is very desirable that more than one professor or instructor be present, especially from other departments related to the ones which for the meeting

sponsor the discussion. Interest shown by the faculty will react strongly upon students.

6. Commercial firms should be encouraged to send representatives capable of giving interesting and instructive talks upon their operations to such meetings, provide slides for illustration and if practicable samples of product or steps of operation in production. Offers for such lectures should be made not later than June for the following school year beginning in September and give synopsis of proposed talks. This will enable colleges to arrange definite programmes for the year, select the lectures or exhibits desired and give time so that colleges and manufacturers can mutually arrange a schedule and itinerary for the lectures which will be most economical.

7. At Rose many years ago there was organized a so-called Students Scientific Society to meet the problem before us. Juniors and Seniors were active members, Sophomore and Freshmen visiting and contributing members; monthly meetings were to be held, etc. The results have not been entirely satisfactory. Sometimes much interest was evinced, at other times none, in general the success depended upon the organizing ability, activity and initiative of the student officers and upon the real interest developed in the first meeting or two.

For some years there has been maintained a student Branch A. I. E. E., with fairly satisfactory results, though the burden of providing programmes, etc., usually fell upon the professor. Attendance voluntary, meetings in the evening.

In several departments there has been carried on an exercise, scheduled as a Journal Review in some weekly, in others monthly. The time for these was taken out of the regular hours scheduled for the department. The exercises partook of the nature of the ones suggested, a kind of general Seminar. These were compulsory and credited in the usual manner. They are still carried on in one department regularly, in others sporadically. Results good.

In small colleges the maintenance of student branches affiliated with national societies is difficult. To stir up real interest requires an attendance of from 20 to 30 at a meeting, these must in general come from the two upper classes, if voluntary only from 25 to 30 per cent. of the members will be present at each meeting. Say with a total of from 75 to 150 in four branches of engineering this will give an average attendance of about 5 at each meeting, not enough to create interest and stimulate to effort. I believe that if the several student sections could be organized into one Society, retaining their privileges in the Engineering Societies Branches, better results could be secured. Subjects selected for discussion should be sufficiently general to be intelligible and of interest to at least two of the departments and so scheduled that every one would at least once a month find upon the program a lecture of interest to him. This will not only provide for a fair attendance but will tend to broaden the student vision by acquainting him with problems occurring in engineering related to his own special branch.

If the several Engineering Societies would provide a few lecturers, carefully chosen, to visit the colleges and address the student branches, I believe splendid results would follow. A lecture from one outside the Faculty will in general make a more lasting impression and create more interest than if given by a member of the faculty who gives, say 100 lectures per term to his class. A lecture of this type on some special topic, if missed, is counted by the student as a one per cent. loss. A non-resident lecturer, giving but one lecture, if his discourse is unusual, is counted a nearly 100 per cent. loss. A lecturer of distinction known to the students because of his work in Engineering or representing a great national engineering society, will tremendously stimulate the boys and fix their interest. That young engineers should become members of engineering societies as early as possible in their career seems to me most desirable. If he has been a student member of such a society in college and if the society has been useful to him as a student in bringing him in contact with engineers standing high in their profession he will in all probability desire to retain membership in the Society feeling that he is in a way already known there and is among friends. This feeling can be made very strong if he has been permitted to come in personal contact with a representative of the Society of the right kind in student meetings. Thus student sections would become fruitful feeders for the parent Society.

Experience in trying to maintain a large number of sections of different engineering parent associations or keeping alive many small specialized clubs in a district has shown how difficult it is to keep alive the organizations and has led to the formation of larger organizations composed of the smaller sections without losing their individualities, so far the plan seems to work out well, an example of this is the Science Tech Club of Indianapolis.

I believe it would be an excellent plan to have a committee or members of the several engineering societies suggest to colleges and student branches subjects for discussion, study or even laboratory investigation, briefly discuss their immediate importance and refer to sources of information upon the problem. Practicing engineers are more familiar with the immediate practical outstanding problems in engineering than college professions can possibly be, at best it takes much time before they can be presented in current or permanent literature. Often a knowledge of a really existing problem is the important step towards working out a solution. Such suggestions will be most stimulating to the student, he will have the feeling that he is doing something real in engineering, not only going to school. He will be encouraged to do extra work and reading. Should from time to time a student's work be such that (as even with reservation) it merits notice or publication in engineering literature the result will be far-reaching in animating him to future greater effort.

Anything that partakes of the unusual, lies outside of the routine, is attractive and commands interest. To make the proposed exercises of that character will, I believe, be profitable to students and should be pleasurable to engineers who aid in making engineering education effective.

Sincerely,

C. L. Mees,
President Emeritus,
Rose Polytechnic Institute.

April 9, 1920.

Referring to Question 3 in your questionnaire. The opinion is expressed, "That if possible attendance upon the meetings of engineering societies should not be made compulsory but methods devised by which students would be stimulated to take active interest in these meetings and make them of real value."

I have thought of several ways to accomplish this. The means suggested may not be practicable. However, I briefly present them to you for consideration, criticism and discussion.

In order that all students in colleges where several different engineering courses are offered may be equally interested, the S. P. E. E. should suggest to the American Society of Civil Engineering, the American Chemical Society, that provision be made for the organization of Student Sections similar to the plans of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, and that through a committee of the S. P. E. E. there be brought about as nearly as possible uniformity in the plans for the institution and operation of the sections of the several parent Societies.

For smaller institutions where it is not practicable to maintain from four to five independent student sections of the several parent associations an organization somewhat as follows may be practicable.

ORGANIZATION.

An Engineering Society to be made up of the Student Sections of say the four great national associations, A. S. M. E., A. S. C. E., A. I. E. E. and A. Ch. S.

There are to be elected appropriate officers for the United Engineering Society, to manage general affairs.

Student sections of the several parent societies are also to elect officers as usually provided. The Chairman of Student Sections to rank as

Vice-Presidents of the United Association. The officers of the several sections together with the officers of the United Association constitute an Executive Committee, to coördinate the work of the several sections.

Each student section to retain its identity in so far as affiliation and relation to the national parent society is concerned.

This form of organization is suggested so that as large a number of students as possible may be given responsible parts in the operation of the societies and be given practice in the executive work incident to their operation.

MEETINGS.

The program may provide for one meeting of the United Society each week, the meetings, however, being under the auspices of several different student sections in rotation so that each student section will be responsible for one meeting each month. After any general business transactions necessary, the meeting will be presided over by the Vice-President who is chairman of the student section responsible for the program of the meeting upon that date.

Each engineering department concerned is to give up one hour from its usual time allotment each month, if needed, to provide for these meetings.

Professors are usually loth to yield time from their regular allotment for such related work. This scheme calls for but one hour per month from each department concerned, to the giving up of which there should be but little objection.

PAPERS AND LECTURES.

These should deal with more general topics related to engineering and of interest to more than one section of the society. Discussions are to be especially encouraged, so that many students will be given practical training in debate. Subjects should be announced in advance to encourage preparation for discussion.

When a more important lecture is given by a visiting lecturer, each student should be required to prepare a digest of the lecture in the form of an essay to be submitted to a student and faculty committee for grading and credit. (See credit.)

The object of this provision is again to engage as many students as possible in the activities of the Society. It will be impossible to have each student present a paper because of the limited number of meetings. The requirement that a digest be prepared by each student upon the more formal lectures given by visitors in order to receive credit as provided will engage each student's attention. Subjects chosen being of a more or less general character will make this practicable.

CREDIT AND GRADING.

(*A*). Papers and digests are to be graded by a faculty and student committee, and students are to receive a percentage credit in the engineering department to which the paper may be related and to which the student section of which he may be a member is affiliated. A percentage credit shall also be given in the English Department based upon the literary merit of the paper.

In general, a student will not be stimulated to extra effort unless he be given some tangible recognition of his work. The scheme of grading is only suggestive—it credits the student in that he may raise his scholastic mark by active participation in the society work.

(*B*) Upon the record of the institution and upon the reports given students a separate annotation shall be provided for, indicating the fact that he has or has not been an active member in his proper student section, and some estimate of the degree of interest and activity shown.

It is believed that if through some such means there be kept before the student the fact that evidence of interest and activity in student societies is rated as valuable he will be further encouraged to take part in the work.

(*C*) A full roster of the officers and student members of the section shall be transmitted to the national parent society through the faculty-student committee, and once a year this list should be printed in the proper publication of the parent society. Students who have failed to attend sixty per cent. of the meetings of their respective sections shall not be certified as active members.

The appearance of a student member's name in the national parent association's publication will be a powerful incentive to active membership. The student will feel that his effort is recognized not only in the college but in the ranks of the profession into which he aspires to enter. He feels that he has been formally introduced to it.

(*D*) In all cases where a student refers to his institution for credentials and such credentials are given to prospective employers, special reference shall be made to his having been a voluntary member of student engineering societies, and an estimate of his activity in the work of the societies taken from the records of the institution shall be given.

Employers are usually more concerned about the general personal and mental characteristics of the applicant, and more desirous for information upon these than upon high scholastic standing. The scholastic marks as appearing upon the records of the institution are really the property of the student and should not be given out except upon request from the student. A prospective employer, however, has the right to ask for such general information as to attainment, character and disposition as will enable him to determine the applicant's fitness for the place he seeks. The portion of the formal records of the institution specifying and estimating these characteristics should therefore be furnished prospective employers if asked for. Such general characteristics as faithfulness of effort, dependability, initiative, punctuality, etc., are supposed to be taken into account in the scholastic grade which individual professors return. In most cases, however, they are overlooked, or if taken into account they are so masked that no value can be deduced. A special record estimating these qualities should be kept.

The interest shown and the activity of a student in the work of student engineering societies is helpful in judging of his general personal characteristics. The student should constantly be reminded of the importance an employer attaches to such records and that the employer has a right to ask that such records be open to his inspection.

A general estimate of the student's work and characteristics is of such value that a separate series of grades specifying them should become a portion of the college record. This is done in the Army, where qualifications are rated under appropriate heads, and the record has been found of as great value as the purely scholastic grades in judging of a man's fitness for a certain place. These ratings should appear upon the report given the student. Such headings as

Personal Qualities
Leadership
General Intelligence

suggest topics for rating.

Under personal qualities; industry, dependability, loyalty, readiness to assume responsibility for his own act, punctuality, affability, and address are factors.

Leadership; force, self reliance, initiative, tact, decisiveness, courage, ability to command loyalty on the part of fellows, and ability to meet emergencies, are factors.

General intelligence; quickness of perception, accuracy, ability to grasp new points of view, to find ways and means to overcome difficulties (even if not orthodox), scientific imagination, and good common sense are factors.

The above are only suggestions, and are not fully worked out. They are offered with the view to learn whether it is believed worth while to elaborate them and offer them to the S. P. E. E. for discussion.

C. L. Mees,
with approval of
Professor Wagner, Rose Polytechnic.

April 29, 1920.

I have your letter of April 7, asking for information about our practice in connection with student branches of national engineering societies, and I take pleasure in answering your questions as follows:

1. Without doubt, the engineering colleges should encourage regular meetings of student engineering societies.

2. It is our practice, and it is my opinion, that attendance at these meetings should be regarded as extra activities, exactly as in the case of other general student activities, and that no allowance should be made for such attendance in the preparation of schedules of studies.

3. The officers of our student societies make up their own programs. I feel that in the main the topics which are discussed should be outside and not connected with the work of the class room.

4. It seems to me that if the students are to derive any practical benefit from their engineering societies, the meetings should be conducted entirely by the students without the help of professors, although I think that it is desirable for members of the Faculty to attend occasionally and participate in the discussions as individuals rather than as Faculty men. The societies frequently invite outside engineers to address them. I feel that the students will receive the greatest benefit from their society work if they have the responsibility of furnishing their own programs.

5. Commercial firms frequently request permission to send representatives to address our students about matters pertaining to their activities. In many cases we refer these requests to the student societies, whose officers are permitted to arrange for such lectures.

We have a considerable number of student branches of national engineering societies at Illinois, including the Mechanical, Electrical, and Mining engineers, and the American Association of Engineers. I do not feel that it would be feasible or desirable to give college credit for this work, nor do I feel that the members of the Faculty should take an undue part in directing the activities of these student branches.

It has been my observation that the student engineering societies function effectively in direct proportion to the characteristics of their officers. When we have officers of vigor and initiative, the work of the societies is effective; otherwise it is not. I do not believe that much would be gained, and I fear that many of the benefits of these societies would be lost, if members of the Faculty were chiefly responsible for injecting ''pep'' into their meetings.

Very cordially yours,

C. R. RICHARDS,
Dean and Director,
College of Engineering,
University of Illinois.

April 21, 1920.

I can certainly dictate a letter expressing my own opinions and the practice which we have been carrying forward here at Yale in connection with student branches of engineering societies. I had best answer your questions first.

1. I believe engineering colleges should encourage regular or special meetings of student engineering societies.

2. I think that about one half of the hours devoted to the student meetings might well be taken from the schedule of study hours but that at least one half should be taken from their own time for evening meetings and especially when they bring speakers from outside to present engineering matters to them.

3. As to character of the topic to be taken up, I have always tried to make the students handle this phase of the work. Sometimes it relates very much to the work they are doing and sometimes it is rather remote. I think usually if the officers of the Society are good wide awake men there is no trouble about the character of the material presented.

4. Student branch meetings have been conducted almost entirely by the students themselves. They have of course asked some professors to present material before them but the meetings themselves have been managed by the students.

5. I see no harm in having commercial firms of certain types present material to these student branches. To illustrate, I would say that thermit welding, heating and ventilation, boiler construction and operation, each presented by representatives of commercial firms, have been very satisfactorily presented and any commercial advertising has been entirely eliminated.

It is my opinion that each institution will have to handle this matter of student branches in whatever way seems best fitted to its own environments. I have myself conducted for 25 years a senior seminar at which has been presented by the students themselves technical papers gleaned from current periodicals. The students have been also urged to speak on the floor from notes and we have developed considerable ability to do this in recent years. Because of this particular class room work here I think the presentation of papers at these student societies, by the students themselves, has been omitted, the students feeling that they have enough of that sort of thing in this seminary work.

My observation is that these student branches need a little fathering by some one in the Department and a little help in finding suitable speakers and being sure we eliminate unsuitable speakers.

Debates between several of the societies have in the past created a good deal of interest.

I believe that a very large number of our students have joined the

Society upon graduation largely because of their knowledge of the Society which comes to them through their subscription to Mechanical Engineering and participation in these student branches.

I believe these student branches should be encouraged and given all possible help.

Yours very truly,
L. P. BRECKENRIDGE,
Professor of Mechanical Engineering,
Sheffield Scientific School,
Yale University.

April 9, 1920.

A copy of your letter to the several members of the S. P. E. E. Committee reached me a few days ago, with a copy of the questionnaire sent to a large number of engineering schools enclosed. I have discussed the questions which you have proposed with Dean R. L. Sackett and I think the following answers reflect fairly well the sentiment of our School of Engineering.

1. Yes. We do very heartily encourage and endorse the meetings of student engineering societies. The encouragement is carried as far as we feel it is safe to go, for we want to avoid any suspicion of faculty interference with the independence and autonomy of the societies.

2. As I understand it the question means to ask if the time which is given by the student to the meetings and affairs of his engineering society should be in addition to the time required of him for his attendance at and preparation for the class room and laboratory work of his curriculum. Stated otherwise, should the society work be on the same basis as any other extra-course interests? It is our feeling that the student's society work should be done on his own time. When he gets into the active practice of his profession it will only be in exceptional cases that he will be permitted to use his business time in the work of his societies.

3. No. If made a part of the regular scheduled work and thus *require* the participation of the student, the meetings are no longer society meetings but classes, and the conduct of the meetings, the programs and the degree and kind of participation by each student become matters of faculty control. The students will have but little real voice in the matter and will soon be tempted to form real societies which they can run in their own way.

4. The advisability of taking time "from the regular schedule of studies in order to promote discussions on industrial and social questions" depends largely upon the amount of time given to such subjects in the regular curriculum. We have not felt the need of such work here because all of our curricula, by action of the Board of Trustees,

involve more work in English, history, economics and political science than do the curricula of most engineering schools. The amount of time devoted to such work here has caused some members of the technical faculties to feel that time which ought to be available for technical work was encroached upon. The majority, however, appreciate the value of this broadening work and believe in it. In an institution where the time for work of this kind is small, I believe the plan suggested in the question would bear fruit.

5. We feel that the *initiative* should be with the student, but that members of the faculty may and ought to give a generous amount of assistance whenever such assistance will really help the boy and make the meeting more interesting. I fear that we, here, do not live up to this idea, however, and take rather too much of the responsibility upon ourselves. The meetings are probably better from a professional standpoint, but they probably do not do the boy so much good.

6. We are glad to have the representatives of commercial firms speak at the society meetings provided they do not advertise too obviously. Our experience has been that in most cases the amount of direct advertising is too small to be at all objectionable. Furthermore, the visits of such representatives give us a breath of outside air, a touch with the outer world which in our isolated condition is both refreshing and beneficial. They also give the students ideas about his practical life after leaving school in a way that the faculty can not do. This practice can of course be grossly overdone, but where occasional carefully selected representatives are secured the results are good.

7. At The Pennsylvania State College the students of each of the several departments of the School of Engineering (Architectural, Civil, Electrical, Industrial, Mechanical) maintain an engineering society. The E. E. Society is affiliated with the American Institute of Electrical Engineers, the M. E. Society with the American Society of Mechanical Engineers. The Mining Society is a similar organization in the School of Mines. The five societies in the School of Engineering have recently joined together in a general Engineering Society whose chief function is the publication of the *Penn State Engineer*.

Meeting places for all of the societies are provided without rental. The members of the faculty are seriously interested in the societies, and are very generous in the matter of help in carrying on the meetings by attendance, by speaking whenever they are asked, by helping the students arrange programs, by suggesting outside speakers and by constructive criticism and advice whenever it seems to be needed.

We believe in the absolute independence and autonomy of the societies, and are very careful not in any way to dictate or even to attempt to influence unduly the policies of the societies. We believe that the students should be responsible for the success or failure of their societies, that they must realize this responsibility and that whether the society stands or falls depends upon their management.

Very truly yours,
E. A. **Fessenden,**
Professor of Mechanical Engineering,
The Pennsylvania State College.

April 12, 1920.

In reply to yours of April 8th enclosing circular letter regarding Student Branches of the Engineering Societies would say that in answer to question 1, namely, "Should an engineering college encourage regular meetings of student engineering societies?" the college should in every way encourage such meetings. Not only should it encourage meetings of the separate societies, but it should encourage joint meetings of the engineering societies.

In answer to 2, namely, Should the hours given to such meetings be added to the schedule of studies, or should they be part of the schedule, time being allowed out of the lessons and preparations devoted to the regular work? would say that these should be entirely outside of the regular schedule of required studies.

In answer to 3, "It has been suggested in a number of places that the topics taken up in the meeting hours should be entirely outside of the classroom subjects. Is this the practice in your place?"—The subjects discussed at the meetings have in general been along engineering lines. Occasionally the business side of engineering is covered by a lecturer. As soon as students get a strong organization they have no difficulty whatever in getting practically any speaker whom they desire to get. The Mechanical, Electrical and Civil societies almost never have an attendance less than 70, frequently as large as 300 and at combination meetings the attendance is frequently so large that it becomes necessary to use the large hall of the Walker Memorial which is capable of seating 1500.

(4) Should such meetings be conducted entirely by the students or through the help of professors and outsiders?—Most assuredly the meetings should be handled entirely by the students. If they seek the help of the professors such help should be obtained privately by the officers and the professors should allow the students to run the thing absolutely by themselves.

(5) How far have commercial firms been encouraged to send representatives to such meetings?—Some of the larger concerns have at odd times sent representatives to discuss some of their new equipment, such as conveying material by the use of wire rope and developments of gyroscopes and so on. As a general thing, the meetings have been of a nature dealing strictly with the technical side of engineering. The stu-

dents have always found it advisable here to send their own representative to the Student Section in New York.

The boys have gone on this scheme, that in order to get up enthusiasm it is a good plan to have a large number of men working and it has been the custom to alternate excursions and lectures. Before sending men on an excursion it has been the custom to designate a number of men to go over the plant, making out a diagram showing the course through the plant and pointing out the important items which are to be studied during the visit. These same men who have made a preliminary survey of the plant thus act as guides, each man taking a small section and explaining in detail to that section what he has picked up in his previous visit. Frequently the professors are called upon to act as guides and lead some of the groups. By this means it has been possible to get a large body of students interested, each man having assigned to him some particular job.

It is also of interest to note that a great many of the men who are student members of the A. S. M. E. become Junior members of the parent society very shortly after receiving their degree from the school.

Very truly yours,
EDWARD F. MILLER,
Massachusetts Institute of Technology.

April 20, 1920.

Your circular letter of April 7th is at hand and I am pleased to see that you are moving in the matter of the Engineering Society's interests, to which I will gladly contribute anything that may serve to assist you.

Perhaps it will be best for me to consider the questions in the order named:

1. The attitude of the Engineering Faculty of Tufts is best indicated by the following vote of January 7, 1920: "Voted—that a special hour be set aside on the program for meetings of the Student Branch of the A. S. of M. E., and of any other society that may be formed."

The hour chosen is the last program hour of the afternoon, at which time classes which include the members of the Society are dismissed. The appointment of the day and hour was referred with power to the Dean.

2. This question is answered in Question No. 1.

I have tried to maintain an engineering society at Tufts during the past twenty years and have encountered all of the difficulties indigenous to college life and with somewhat indifferent success, but our last effort appears to be really hopeful. Since the passing of the above vote, a Civil Engineering Society has been organized and is a helpful rival to the A. S. of M. E. Branch, having an equally large membership with increasing interest.

3. Thus far, the topics for discussion or lectures at the Society meetings have been outside the class room subjects, but we are planning to make these meetings a field for the exploiting of some of the seminar or topic work of the Senior classes which work is now being carried on as a regular course of study. Later I may be able to add more suggestions concerning the development of this field.

4. I believe that the meeting should be conducted entirely by the students, although it is desirable to have outside lecturers who may or may not be representatives of the Faculty. Indeed, I believe it is generally better to obtain men from professional fields rather than from the Faculty.

5. There are some commercial firms who have representatives in the field for the giving of lectures to technical schools that I highly approve of, and while this work is promoted by the commercial spirit, the inspiration to the student body given by a man from the professional field is very desirable.

As other suggestions occur to me relative to the development of this work, I will communicate with you, but rest assured that you have my hearty support and willingness to do all that I may be able to for promoting these interests.

With kindest regards, believe me
Very truly yours,
GARDNER C. ANTHONY,
Dean Engineering School,
Tufts College.

April 12, 1920.

Your letter of April 8th called to mind our interesting conversation during the last Annual Meeting of the Society.

Our mechanical engineering students are so small in number that we have merged their activities with that of a general engineering society. This society meets monthly in the evenings and is in charge successively of the students of each division of instruction. Our students therefore, do not function in the particular sense of a student branch.

As I told you last January I feel that the student engineering societies should have a definite hour or hours set aside for them in the curriculum, that is they should be part of the schedule. These meetings should develop the student in the presentation of papers before a group of his fellows, and for that reason I feel that as far as the conduct of the meetings themselves are concerned should be entirely by the students. The papers presented should be reviewed and criticised by the instructing staff.

I also feel that the method followed by the University of Kansas of having an annual meeting day or series of days is a very good policy to adopt throughout the country.

A great danger in having commercial firms appear before the students at these meetings is that it results in an advertising campaign for some particular project. I think that every effort should be made to place the meetings on a high scientific plane.

If I can be of any further help to you in this matter, I trust you will not hesitate to call on me.

Very truly yours,
Walter Rautenstrauch,
Columbia University.

April 12, 1920.

I have your letter of April 8th and your circular letter pertaining to the work of the Student Branches. I would make the following answers to your specific question.

1. I am a strong believer in regular meetings for the Student Branches. In fact, I hold that this is fundamental for the success of any body of this kind. The meetings should be held at regular times and conducted in a like manner.

2. It has not been our practice to give University credit for work in societies of this kind, and I doubt whether our Faculty would look with favor on such a proposition. If we did this for the American Society of Mechanical Engineers we would undoubtedly have to do it for other organizations, such as the A. I. E. E. and certain college publications, and other auxiliary organizations, all of which while valuable, are not now included in the curriculum.

3. While we have no settled policy in the matter of changes of topic, in general we try to present topics that are somewhat outside the classroom subjects. We have tried to make these meetings as broadening as possible, and we try therefore to obtain outside speakers of eminence who can discuss some topic of importance and interest to engineers.

4. The conduct of all such meetings is entirely by the students, or at least as far as possible by the students. On the other hand, these organizations are not likely to live and be active unless some members of the faculty take an active interest in them, and keep them alive. This is necessarily true because of the very shifting personnel of the student body. A long experience with student organizations has impressed this idea upon me, namely, that no student organization is likely to survive and be a vital influence in the life of the University that is not fostered in some way by members of the faculty.

5. We have had a number of representatives of commercial firms speak before our Student Branch meetings with great success. Last year, for instance, the Chief Engineer of the McIntosh & Seymour Com-

pany, builders of very high grade Deisel engines, gave one of the most interesting and impressive talks that we have ever had. Tonight Mr. Hirshfeld, of the Detroit Edison Company, and a former teacher in the College, is to address the branch. Hirshfeld visits us once every year and always presents something interesting and inspiring.

I wish to say also that I heartily approve of the effort that you are making to codify the practices in the several Student Branches. Anything that will throw light on the ways and means of keeping these organizations alive and active, will be gratefully received by the undersigned. With kindest regards, I am,

Yours very truly,

Dexter S. Kimball,
Cornell University.

April 14, 1920.

Replying to your communication of the 7th, I beg to give you the following information concerning the method used for conducting the activities of the student branches of engineering societies at the Kansas State Agricultural College:

1. No classes are scheduled after 4 o'clock on every Thursday, and the time from 4 P.M. to 5 or 5:30 P.M. is devoted every week to regular meetings of student engineering societies. Ordinarily three of the meetings every month are devoted to the specialized societies corresponding with the various curricula. The fourth Thursday of every month is devoted to a general seminar at which time all the engineering students meet together for a discussion of problems of general interest. In scheduling the weekly seminars, all sophomore, junior, and senior students meet in groups in accordance with the several curricula. The engineering freshmen meet in a separate group.

2. Our experience indicates that best results are produced if the meetings of the engineering societies are made a part of the regular schedule, and if attendance is compulsory.

3. The practice at the Kansas State Agricultural College is to devote the time given to meetings of student engineering societies to the discussion of subjects outside of those regularly scheduled in the curriculum.

4. The meetings are conducted entirely by the students. Assistance is given by members of the engineering faculty in connection with the preparation of the program.

5. Our practice has been to have at least one outside speaker every month. With the kindest personal regards.

Yours very truly,

A. A. Potter,
Dean, Division of Engineering,
Kansas State Agricultural College.

April 15, 1920.

In reply to your letter of April 7th, I will endeavor to give you some idea of the manner in which we conduct our Student Branch.

The Faculty of the College of Engineering at the University of Cincinnati is convinced that the value of a club hour is sufficient to justify its place on the schedule. The Student Branch of the A. S. M. E., is scheduled for one hour per week at 11:30 A.M., and every student registered in the Department of Mechanical Engineering is supposed to attend these meetings. We also aim to have from three to five evening meetings per semester.

The students in Mechanical Engineering take the coöperative course and work in about forty manufacturing concerns in Cincinnati and vicinity. They come in contact with many important and interesting pieces of engineering work, and there is no difficulty in getting material for our student meetings. This offers an exceptional opportunity to have topical discussions on such subjects as methods of reclamation and salvage used by various shops. Such topical meetings are announced in advance, and each student learns what he can regarding the method used in the shop in which he is employed, and is prepared not only to appreciate the importance of the subject, but to also contribute to the discussion. One advantage of this plan is that it gives a large number of students an opportunity to enter into the discussion. The following is a partial list of subjects discussed at the 11:30 A.M. meetings of the A. S. M. E. Student Branch:

Oil reclamation as practiced in a machine shop.
System of a machine shop planning department.
Topical discussions on reclamation and salvage as practiced in different shops.
Deflection tests of a milling machine.
The heat treatment of iron and steel.
Time setting.
Motor car repairs and testing.
Testing centrifugal pumps.
Construction and testing of air compressors and pumps.
Gas producer plants.

These talks were based upon the student's practical experience which he gained on his coöperative job.

The evening meetings are used to bring both sections of coöperative students together, and to have a member of the A. S. M. E. address them on general topics relating to the industries and business. At the last meeting, Mr. E. A. Muller read a paper on the development of the machine tool industry in Cincinnati. Mr. George W. Galbraith has been present at practically every evening meeting for years, and his brief discussions and remarks at such meetings have no doubt been a great inspiration to the students. Other members who have taken an active interest in the student section, and who frequently attend the meetings are:

F. E. CARDULLO,
A. J. BAKER,
M. RIESNER,
E. W. VINNEDGE,
E. F. DUBRUL,
JAS. B. STANWOOD.

The presence of mature men at these meetings is undoubtedly a great inspiration to the students. The main idea is to have a minimum amount of formality, and a maximum amount of inspiration.

I wish to make the following specific answers to the questions mentioned in your letter:

1. Engineering Colleges should encourage regular meetings of the Student Engineering Societies.
2. Club hours should be a part of the schedule.
3. Topic should be outside of class room subjects. Such is the practice at the University of Cincinnati.
4. Meetings should be conducted entirely by the students. A copy of the minutes of the meetings should be filed with the Honorary Chairman.
5. All evening meetings are addressed by representatives of commercial firms.

The hour devoted to the Student Branch is designated on the schedule as the "club hour," and is the same for all five classes, namely, the Freshman, Sophomore, Pre-Junior, Junior and Senior. The attendance is not compulsory; neither is it exactly voluntary to those students who ignore it. I have gotten the names of those who are habitually absent, and explained the importance of their attendance, and we have a very good attendance. It is up to the student officers to make the club worth attending.

One of the annual events at the University is the Student A. S. M. E. Dance, which is one of the important social activities of the University.

It is extremely important that the proper students are elected to office. There might, at times, be a tendency for fraternities to elect certain men for office, simply because they happen to be members of some particular fraternity, as they frequently do in selecting class officers. In the coöperative course, the Chairman is in one section, and the Vice-Chairman in the other. It will be seen that it is almost necessary to duplicate the student officers, in order to have one for each section. We also have a rule requiring the officers to be distributed among the classes. There is a considerable list of committees which places responsibility on a large number of the student body. Every student registered in the Department of Mechanical Engineering is looked upon as a student member of the A. S. M. E. We encourage the Seniors to become Junior Members upon graduation. Last year every Mechanical and one Electrical graduate entered the A. S. M. E. as a Junior Member, and I think we will have at least one hundred per cent. enrollment in the Society by our present Senior class.

With my very best personal regards, I remain,

Very truly yours,
A. Lewis Jenkins,
Professor of Mechanical Engineering,
University of Cincinnati.

April 19, 1920.

In answer to your communication of April 8th, my own opinion in regard to these questions is as follows:

1. I believe that the engineering colleges should encourage regular meetings in their student engineering societies at least once a month.

2. I believe that the students should be allowed time out of their regular lesson periods for attending such meetings:

3. I think the topics taken up at these meetings should be topics of general interest, and as far as possible, these meetings should serve to broaden the student's viewpoint and bring him in contact with the wider view of the engineering field. In conducting assemblies for students I have often introduced speakers on subjects entirely outside of engineering, even going so far as to have professors of music, philosophy, and medicine talk to the engineering students.

4. I believe such meetings should be conducted as much as possible by students, the students calling in from time to time, professors and men outside of the institution to present papers before their Branch. I think the chairman in charge should only exercise a guiding hand and should leave the students as free as possible to conduct the meetings in their own way.

5. A few meetings conducted by commercial concerns are oftentimes beneficial, and some excellent matter is presented. I believe, on the other hand, that it is very easy to overdo this character of meeting. It has always been my thought that the Student Branch meetings should largely be conducted for students and the papers presented should be largely those presented by students, so that the engineering student may be encouraged to walk upon his feet and to study subjects outside of the subjects of the classroom during his engineering education.

One of the conspicuous deficiencies of most engineers is their lack of ability to express themselves on their feet before an audience. Public speaking should be encouraged for engineers, particularly in these Branch meetings where the young man has the very best opportunity to develop the ability to speak.

I will try if possible to write something on this subject after my return from my Southern trip.

With best regards, I remain, Very truly yours,

JOHN R. ALLEN,
Director,
U. S. Bureau of Mines.

April 13th, 1920.

I have time only to answer your letter somewhat briefly altho' my interest, as you know, is not measured by the length of my reply. What I say here might well be supplemented by the report prepared by the Stanford Student Branch, which I had the pleasure of presenting at the May meeting of our A. S. M. E. Committee.

Answering your questions in their order:

1. Yes, *encourage* not *require.*

2. Neither. The matter should be left entirely in the hands of the Student Branch free from all official academic control or assumption of authority or responsibility.

The affairs of the Student Branch should constitute an independent student activity, through conducting which by themselves they may gain the benefit of the growth that comes from the responsible direction of the organization, the planning of its activities, programs, etc.

There should be no academic ''credit'' given.

3. It is, practically.

4. See answer to 2. Professor should act in advisory capacity solely, and preferably only when their advice is sought.

''Outsiders'' should be completely barred, particularly those whose aim is propaganda of one kind or another. Specifically I refer to the activities of the National Industrial Conference Board.

The parent organization of the Student Branch should not interfere in the conduct of its affairs.

5. Our students make it quite a common practice to invite *bona fide* representatives of commercial firms to address them.

As indicated above, I do not at all like the idea of meetings under academic control at definite hours, and think the best way of getting rid of the misrepresenting term ''seminar'' used to designate these would be to do away with such control and use the term ''meetings.''

I am heartily at one with you in desiring that all men who are going into our profession should have a fine, broad education—fitted to the conditions of the present day—and to that end am particularly desirous that they be not trained in a habit of thought which the very technological system in which they are to function has rendered obsolete.

Sincerely yours,

GUIDO H. MARX,
Leland Stanford Jr. University.

April 10, 1920.

At the Rensselaer Polytechnic Institute the student branches of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers have meetings once a month during the scholastic year. The Civil Engineering students have established an association of their own. They also meet once a month. These meetings are held in the evening and generally last about two hours. All three of the organizations generally have at each meeting an engineer of more or less eminence from outside the Institute who reads a paper or delivers a lecture which is afterwards discussed.

I do not believe that hours given to such meetings should be scheduled. They are not part of the regular work of the students, and attendance at these meetings is voluntary. The topics taken up at these meetings are generally entirely outside of class-room subjects. Naturally they are engineering topics. Instructors who belong to national engineering organizations are naturally interested in these meetings and some of them are always in attendance. We never have made any requests for commercial firms to send representatives to these meetings. Men who have been asked to read papers or to lecture at them may or may not have been connected with commercial firms.

Palmer C. Ricketts, *President,*
Rensselaer Polytechnic Institute.

June 18, 1920.

I beg to tender my sincere apologies for having failed to return the answers to your questionnaire in regard to seminar activities at my institution. In cleaning up my desk I found that I had failed to make the return requested and I hasten to do so now in the hope that the material my add to the completeness of your study of the situation.

1. I certainly favor and encourage meetings of student engineering societies and branches of engineering societies.

2. I favor having the hours for such meetings added to the scheduled hours of the curriculum.

3. There is much to be said in favor of making attendance upon such meetings compulsory inasmuch as it seems particularly difficult to bring the students to a full realization of the importance and benefit of such meetings, nevertheless I believe the attendance should be voluntary rather than compulsory with every effort exerted to get the men interested.

4. Undue multiplication of extra-curricula activities ought to be minimized in my opinion. There are so many subjects that might be taken up outside of class activities that the danger lies in attempting too much with the result that little or no valuable work would be actually accomplished. It seems to me that such outside material as

seems highly essential ought to be incorporated in the society meetings rather than attempting the larger program of compulsory weekly attendance upon those special topics.

5. I favor a combination of student initiative and faculty advisory attitude in connection with such meetings, working toward a maximum of student control.

6. I favor a reasonable amount of coöperation from commercial and industrial firms as very often their information is valuable and instructive.

7. At the University of Virginia we have a Branch of the A. I. E. E. which meets monthly and to whose meetings all interested are invited. We have also a local honorary engineering society which meets regularly but whose meetings are not open and consequently the material presented is confined to members who are chosen from the upper fourth of third and fourth year men.

I believe that these meetings serve a most useful purpose and my chief regret is that such a small number of men usually attend.

I have always felt that the National Societies might contribute very usefully to Engineering Schools by means of various specialized articles in the society journals and I believe the tendency is continually toward such helpful attitudes.

Very sincerely yours,
WALTER SHELDON RODMAN,
Professor of Electrical Engineering,
University of Virginia.

REPORT OF COMMITTEE TO COÖPERATE WITH THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

C. L. Mees: Mr. President and gentlemen: I thank you for the courtesy of calling upon me because President Hollis already indicated that our coöperation was so perfect that nothing remained for me to say. I trust we have set a good example of how two committees can work together in perfect harmony. We had a conference out West, at which time he stated he did not think we could do very much. We then proceeded to enter into lengthy correspondence, exclusive of questionaires, and that correspondence, I suppose, is included in the material which he has to furnish the society. I did make some few specific recommendations or suggestions, which I thought might be worth while for a joint committee to consider. But, as no formal meeting was held, I do not know whether it is worth while to take up the time of the society now. I agree with Dr. Hollis that the time is opportune for the appointment of a larger committee.

Several voiced the objection that the larger institutions in the establishment of their student branches, followed different policies and that they had entirely different thoughts in mind. As most of the engineering schools have different departments, mechanical, civil, chemical, electrical and so on, naturally if in only one or the other of these engineering branches, a student branch is established, and efficient work is being done with the assistance or without the assistance of the national association the others having no affiliated student branches feel somewhat slighted and there is considerable difficulty in maintaining the interest. I think the suggestion which Dean Cooley made this morning might be carried out profitably, and it was among the suggestions I had in mind when I wrote to Dr. Hollis, that is, the establishment of general engineering societies, made up of sections or sub-sections, affiliated with the several national societies; there might be sectional meetings of these as well as meetings of the general engineering society, and as nearly every college body desires to have officers, and every college boy wants to be president, vice-president, or a member of a committee at some time or other, that would give an opportunity for a large number of presidents, vice-presidents and committee members, who would do either nothing, or practically nothing, as the case may be. Yet would perhaps have this interest stimulated. I am afraid that which Dean Cooley suggested this morning is true, that up to date the object has been only to have these student sections act as feeders for the central societies. I believe the national societies can do a great deal of good in that way.

It was pointed out that it is easy to have moving picture shows and that sort of thing to present topics which are of doubtful value. However, if the societies would appoint committees made up of men well qualified to talk to students and pay their expenses, or a nominal sum, who would from time to time visit the different societies at the different institutions, and from the breath of their professional experience and the broad experience and the broad views they take, address the students, the effect might not only be stimulating, but they might do a great deal of good in touching upon topics which ordinarily do not enter into instruction. To the ordinary student, the professor is an everyday proposition; he is a good deal like an "everyday need." Although he may perhaps speak upon a general topic in a manner which may be as well thought out, as well well worked out, as any visiting engineer would have done, the student takes it as upon the regular bill of fare. There is something more impressive in having a man who is known to be in the actual engineering work, and not merely a teacher of engineering, come and present his views and points out to them the attitude which they should take toward the profession. That was along the line of suggestion which I thought possibly the committee might take up.

As undoubtedly the report of Dr. Hollis will receive consideration and the suggestion which he has made with reference to the appointment of such a larger committee will be met, it is unnecessary for me to go into the details of the suggestions which were presented to me as a member of the committee, because Dr. Hollis says we did not meet as a committee, and possibly his report can find favorable action. I trust that may be so. There is an opportunity there, I think, in doing real constructive work more from the side of the National Association than from colleges, and I think the colleges are in a very receptive mood. They have tried to make the student sections profitable, and sometimes, in one year, depending upon the first two or three meetings and the officers who direct them, they are very successful, and the very next year they may be flat failures. I think a great deal of assistance may be given by the National societies in the way of making them more uniformly successful. Even the recognition by the national societies of the student is stimulating. The student feels he has already entered into the rank of the engineering profession, you might say, and he can become known in it through membership in engineering societies. In that connection it is possible to emphasize a little more strongly what the prospective employer and the practical engineer wants to know about the student. Usually the institutions are called upon to recommend students for this, that, or the other position. The employers come to us with open arms and it is sometimes quite embarrassing to know exactly what to say about the individual student. I think it may present to the students the fact that it is not simply the narrow technical scholastic training that they want, but they want men of breadth and earnestness, and initiative, and above all honesty of principles, and if that will be impressed upon him it will have a distinct effect upon the attitude which the student assumes toward the college.

I thank you for the courtesy of attracting the attention to me as having served upon the committee, even if the committee appeared non-existent.

DISCUSSION.

M. E. Cooley: I want to say at the outset that I do not agree with Dr. Hollis on some of his statements. He himself is the best proof of my reason for not agreeing with him. He says a broad foundation is not necessary for an engineer, and refers to the Naval Academy as being the narrowest educational institution in the land. He himself refutes both arguments. He came to the Naval Academy with a broad preparatory training which included the classics. I lived with him for four years, and all the classics I know I got from him. I am not saying how much. The Naval Academy in my opinion is a wonderful institution. I have long advocated the kind of education that is given there. It does one thing that no other institution in the land, unless it be West Point, does to the same extent. It trains a man in self-reliance. Students are not taught at the Naval Academy. They learn by digging things out for themselves. That is great discipline. Moreover, the graduate of the Naval Academy spends his life traveling about the world. That itself is the broadest kind of education. So, I do not agree with Dr. Hollis.

Now, to the queston of coöperation. It is a big subject. It deserves the fullest consideration of this society. There are several aspects. I can only discuss one or two of them. I believe this Society should after twenty-eight fruitful years of study begin to get results. So far as I can see, few actual results have made themselves manifest. Why not? Up to now we have not coöperated. The engineer who teaches and the engineer who practices have not got together. They have worked apart from each other.

I myself doubt whether much help may be expected from practising engineers. Not many of them will feel able to do much towards helping to solve the problems of education. A few years ago I sent out a questionnaire to our graduates—some 1,200 of them. About 800 replies were received. Four of the questions related to changes in our curriculum. Only one person pretended to answer any of the questions, and he was a college man. The rest of them begged off on the ground that they were out of touch. They were busy making a living, and had not thought of it. The national societies are waking up and it may be that from now on we shall see more coöperation. They should join with this society in educational matters. With all our efforts combined, worth-while results should be accomplished.

Thus far, the only attempt at coöperation has been through the so-called student branches of the National Societies. I fear the motives behind such coöperation have not been wholly unselfish. I have heard it stated by officers of the national societies that the student branch was one of the best means to increase their membership.

Membership in a national society is, of course, highly desirable for the young professional man; and the larger the society the more influential it is. But unless backed by a wise policy the student branch may become a mere forcing process. Fortunately, Dr. Hollis himself is in charge of student activities for one of the national societies.

Dr. Hollis thinks the national societies should come together and do jointly what they are now trying to do separately. That would be a wise movement. It should extend to the student branches also.

Thirty-five years ago we had here just one engineering society, and it was a great success. It met regularly and had its own programs. The members did their own speaking, their own debating, and managed everything in their own way. It was a live society, one of the livest on the campus. Then came the student branches, and this one engineering society was divided into several. The older engineering society now amounts to practically nothing, and the student branches, likewise. The suggestion that the national societies join hands is a good one. It will tend to union, and that tends to strength.

Would it not be practicable and worth while to have a committee or some organization in this society which shall embrace members chosen by the national societies? We have in this society institutional members—some seventy of them. Twenty-nine state universities, thirteen agricultural colleges and thirty endowed institutions are represented. What I propose and hope can be brought about is an organization of these administrative officers which shall also embrace representatives of the national societies. This committee could meet once a year, or oftener, and discuss the problems that are common to all the institutions. Out of the discussions, recommendations might come which could be adopted by all with much benefit. The literary colleges in the Middle West have an association of Deans which meets once a year. It is very successful, I am told.

Let me mention a few examples of problems that might be considered by such a committee or organization: entrance requirements, graduation requirements, curricula, a longer course than four years and what such a course should embrace, whether it shall be a broader course, or more technical, whether we should attempt to differentiate between engineering schools giving a broad training or those that are highly specialized. An important subject would be research. Shall it be duplicated or divided up into fields, one college devoting itself to one kind of research and another to some other kind. A certain amount of equipment is needed by all for undergraduate work but why duplicate the equipment for advanced work not done by undergraduates? Such a plan if found practicable, would vastly increase the effectiveness of equipment, and it would avoid duplication of effort. It would bring to a practical realization the key-word of this convention, "Coöperation."

Mr. President, I have the feeling that the Society for the Promotion of Engineering Education has the opportunity to do something that has never been done, and can do it in a most effective manner. What I have suggested but broadens the idea of Dr. Hollis. He spoke of coöperation as between the national societies and the educational institutions. My suggestion would bring together the national societies, the Society for the Promotion of Engineering Education and the administrative officers of the engineering schools, all for the common purpose of advancing engineering education to the end that the professional engineer may render more and better service.

J. H. Dunlap: One phase of the subject of the paper by President Hollis on "Coöperation of the Engineering Societies with the Engineering Schools," is of special interest to the writer, namely, coöperation with the engineering societies in the standardization of engineering education. If an effort at coöperation along this line is desirable, it should be possible to show that such a project is a logical outgrowth, both of the history of the profession, and of its present status. The process of evolution of a world, and of its parts, leaves no gaps. Accordingly, such a proposal should be viewed first, with reference to the sequence of past events, and second, with reference to the trend of present conditions.

The Sequence of Past Events.

Before the Civil War only five engineering schools were in existence, the United States Military Academy at West Point, which sent forth its first graduates in 1802; the Rensselaer Polytechnic Institute, where the civil engineering course was added in 1829; and the three schools establishing courses in 1847, the Lawrence Scientific School at Harvard, the Sheffield Scientific School at Yale, and the University of Michigan.

Following the passage of the Morrill Act in 1862, granting federal aid to the states for founding colleges of agriculture and mechanic arts, there was a remarkable increase in the number of engineering colleges, until in 1917 there were 126 engineering schools of college grade. Up to 1915 these colleges had granted 55,000 engineering degrees.

During this period the length of the curriculum has increased from the one-year course during the early history of the Rensselaer Polytechnic Institute, to the six-year course now in operation at Columbia University. From one general course covering all that was then known of civil engineering, the number of courses at our institutions has developed until we have as high as fifteen specialized courses given by one institution. In 1837, when Professor Mahan, professor of military and civil engineering at the United States Military Academy at West Point, wrote and published the first treatise on civil engineering in English, it was possible to cover the whole field within the covers of one book. Now, an extensive library is required for the investigation of the data available in any branch of the profession.

The contribution to this development made by the Society for the Promotion of Engineering Education was ably and comprehensively stated in the paper of last year by Past-President George R. Chatburn. The achievements of the committees of the Society are notable; such committees, for instance, as the committee on standardization of entrance requirements, and the joint committee on graduation requirements, and the joint committee on engineering education whose report was discussed at the last meeting of the Society. To have assisted in making possible the report by Charles R. Mann, "A Study of Engineering Education" is in itself a noteworthy contribution to the progress of the engineering profession.

The Trend of Present Conditions.

Keeping in mind the development of engineering schools, and of engineering curricula, and also the contribution of this

Society to the development of both, we can perhaps best show the trend of present conditions by contrasting the situation in the medical, legal and engineering professions twenty years ago with the situation to-day. The following table on professional education in the United States for 1898–99 is adapted from Table 4 of the president's address on "Engineering Education in the United States at the End of the Century" by Professor Ira O. Baker, presented in 1900 at the New York meeting of the Society. It will be noted in the table that during the year 1898–99 only 14 per cent. of the medical schools required for admission more than one-year high-school course, as compared with 33 per cent. of the law schools and 80 per cent. of the engineering schools. Moreover, 91 per cent. of the medical schools had a four-year course with an average of 28 months in attendance, as compared with 98 per cent. of the engineering schools with an average of 35 months in attend-

PROFESSIONAL EDUCATION IN THE UNITED STATES FOR 1898–99.

Adapted from Table 4 of the President's Address on "Engineering Education in the United States at the End of the Century" by Professor Ira O. Baker. *Proc. S. P. E. E.*, Vol. XIII, 1900, p. 16.

Item.	Law.	Medicine.	Engineering.
Schools	86	156	89
Requirements for admission:			
College degree	2.3% require college work	0.7%	1.1%
Completion of junior year			
Completion of freshman year			
4-yr. high school course	3.5%	8	4.1
3-yr. high school course	14	2	24
2-yr. high school course	13	3	51
1-yr. high school course	9	62	17
Common school	30	19	
None or indefinite	28	1	4
Length of course:			
4-yr. course		91	98
3-yr. course	51	6	1
Less than 3-yr.	43	3	1
Average length of yearly session	7¼ mo.	7 mo.	8.7 mo.

ance. The law school course was much briefer than that of either of the others. Accordingly, twenty years ago the requirements for admission to engineering schools as well as the length of course greatly exceeded those of the law and the medical schools.

The same tests applied at the present time show changes decidedly unfavorable to the engineering schools. The medical schools, twenty years ago at the bottom, are now at the top; while the engineering schools, twenty years ago at the top, are now at the bottom, with the law school in a middle position. Furthermore, the leading dental colleges will require in 1921 one year of liberal arts college credit for entrance to the four-year dental course. Moreover, the graduation requirements of the leading schools of theology now consist of a four-year liberal arts course plus a three-year theological course. Accordingly the engineering colleges, requiring four years of study in addition to a four-year high-school course, are now fifth on the list of professional colleges. Indeed it is very doubtful if they should be classed as professional colleges at all. There is certainly much justice in classifying technological schools in the reports of the United States Bureau of Education with universities and colleges, while schools of medicine, law, dentistry, theology, pharmacy and veterinary medicine are classed together as professional schools.

These advances have not been brought to pass by the medical, legal and dental professions without great effort. After years of work the Council on Medical Education of the American Medical Association has prescribed standards by which medical schools are now classified into A, B and C classes. The State Medical Examining Boards have coöperated voluntarily, by deciding that they would accept only graduates from recognized schools. As a result of this policy, there are now 85 recognized medical schools, 78 of which require two years or more of work in the liberal arts college for entrance to the medical course. Furthermore, eight schools are now requiring, in addition to two years' work in a liberal arts college, and a four-year medical course, a seventh year as intern before granting the degree of M.D. In addition to the standardization of medical schools, a model curriculum has been prepared.

In the case of law schools, rapid development is now taking place. Among the fifty law schools holding membership in the Association of American Law Schools, about twenty now require two years or more of liberal arts work for entrance to the law course of three years or more. The American Bar Association is at work on the problem of standardization of law schools. It is expected that the meeting of the association at St. Louis this summer will initiate a plan which will accomplish this end.

It is interesting to note that the curricula of the law schools have followed so closely the leadership of the law schools at Harvard and Columbia that there is no need for a model curriculum.

In the case of the dental colleges, the Dental Faculties' Association of American Universities and the Dental Educational Council have been engaged for some time upon the problem of standardization of dental schools. In 1921 the dental colleges holding membership in the Dental Faculties' Association of American Universities will require one year of liberal arts work for entrance to the four-year dental course. It is expected that this requirement will be raised later to two years' liberal arts and four years' dental work. The final step is expected to be a seven-year course with combined work in the liberal arts college, the medical college, and the dental college.

Certain immediate effects of the higher graduation requirements of the medical, legal and dental schools are obvious. In the first place, the more thoughtful and resourceful students, other things being equal, will be attracted to these professions by the fact that they are apparently of higher grade than the engineering profession. In the second place, the students who come to a university as they would come to a trade school, with the purpose of finding the shortest cut to a fairly respectable job that will provide them a living, will be attracted to the engineering profession. In addition to these immediate effects, it is not difficult to forecast something of the ultimate result of the competition for leadership in a given community between graduates who have been broadly and thoroughly trained in the medical, legal and dental schools, and graduates who have been narrowly and superficially trained in the engineering schools. We will all agree that engineering schools should be, and are, consecrated to the task of fashioning a human product which shall lead our communities into ways of keen analysis of their problems, and the economic execution of every kind of project. But without the broadest and most thorough training, will such leadership be gained by the engineering profession?

A clear statement of the issues involved is contained in the following incident from a paper by Nelson P. Lewis,* chief engineer of the Board of Estimate and Apportionment of New York City, as follows:

> The head of a large industrial corporation, who was also the chairman of a board of trustees of an engineering school and was urging the broadening of engineering education, put the case in this way: "We can get plenty of men who are technically competent, who are careful and thorough in their investigations, whose conclusions we know to be sound, but who cannot make a favorable impression before a board of directors. We can get plenty of lawyers who, after being coached by our engineers, can glibly and even convincingly talk to the same board of directors until some question is asked which has not been covered in the process of coaching, when they too will flounder about. If we can secure a man who possesses the conscientious thoroughness and accuracy of the engineer, and also has the facility of expression and persuasiveness of the lawyer, what is a salary of $25,000 or of $30,000 for such a man?"
>
> He therefore urged that this particular school, instead of trying to turn out a large number of $2,000 to $5,000 men, give to the profession a limited number of $25,000 to $30,000 men.

In this connection one cannot help inquiring to what extent the prevailing complaint against underpay by the engineering profession, both practitioners and teachers, is due solely to the faults of the individuals themselves in not possessing the qualities of leadership which are always held at a high premium. As an illustration of this phase of the situation, the following advertisement in *Engineering Education* for May, 1920, is of interest:

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* Nelson P. Lewis, "The Colleges Should Humanize Courses in Engineering," *Engineering Record*, Vol. 75, February 10, 1917, p. 213.

> Applications are invited for the head of the department of mechanical engineering in a southern state university. The present initial salary is $2,100 for eight and one half months' work. Action is pending in the legislature on increased appropriations to raise the salary scale 50 per cent.

Factors in Standardization of Engineering Schools.

With engineering schools at the bottom of the list so far as requirements for graduation are concerned, it would seem that it is high time for the development of a comprehensive plan for the standardization of engineering schools and of their curricula. The following factors are suggested as of possible importance in such a plan for standardization. The factors are based to a large extent upon the present schedule for grading medical schools.

1. Length of curriculum including requirements for entrance, etc.;
2. Character of curriculum, grading of courses, sequence of subjects, supervision, administration, etc.;
3. Engineering school buildings, adaptability, heat, ventilation, cleanliness, etc.;
4. Laboratory facilities;
5. Coöperation with the industries;
6. Student organizations and extra-curriculum activities;
7. Full-time instructors and assistants with special reference to their qualifications and evidences of their work including research;
8. Faculty, number, qualifications and organization;
9. Library, museum, charts and special apparatus, and evidences of the use made of them;

10. Showing of graduates at state board and other examinations, and other evidences by which the training received is indicated.

Of course the preparation of a model curriculum would be one step in the process of standardization.

Objections to Standardization of Engineering Schools and Curricula.

Objections to any proposition for standardization of engineering schools and curricula may be expected. When the combined liberal arts and medical course was proposed, such a plan was pronounced by one distinguished educator to be pernicious; by another, "to be a very dangerous process, that indeed there is no more alarming process now going on in the United States in regard to education than this." Associations of college presidents protested against it, and resolutions to prohibit the practice were considered by the board of regents of the University of the State of New York. The lengthened course was declared to work a hardship upon the poor boy who wants to get an education. The unanswerable question was propounded, "Who will practice at the country crossroads and the backwoods districts if a thorough medical training is insisted on?"

Two possible objections to the project under consideration may be briefly discussed. In the first place, it may be objected that standardization will mean stagnation in engineering education rather than progress. The practical answer to such an objection is the experience of the medical schools of the United States. Standardization in the sense that all institutions would be in the same lock-step is not intended. For instance, it is said that no medical school in the country conforms to the model curriculum prepared by the American Medical Association, and yet every medical school is profoundly grateful that such a model curriculum has been prepared. By such standardization as is contemplated, sufficient elasticity would be provided so that the individualities of the various schools would not be unnecessarily interfered with. By frequent revision of the standards, progress made in any direction anywhere would become quickly available everywhere. The individuality of different teachers would be reflected in the different content and length of the several parts of the curriculum of any institution.

A second objection, more real than the first, is that additional requirements for graduation will decrease the number of graduates, and that at the present time there is a great under-supply of engineers. If there is at the present time an under-supply of engineers, the advertisements for positions wanted in *Engineering News-Record* and the activities of the employment agencies seeking employment for engineers give an erroneous impression. Such increases as have been made in the requirements in the past have not had the effect of greatly curtailing the number of engineers. The law of supply and demand has worked very well in the past and may be expected to in the future. At times there will be a scarcity of engineers, and at other times as we all know, there will be a great surplus.

The Next Step.

President Hollis, in his address before this Society last year, on "Engineering Colleges and Administration," gave as one of his conclusions, "that the national engineering societies should be asked to coöperate not only with this association, but with the colleges themselves toward broadening out engineering education." In harmony with this suggestion and with the facts stated in this discussion, it is believed that this society should appoint a committee on curricula of engineering schools to coöperate with the existing committee on curricula of engineering schools of Engineering Council, the membership of which consists of Alexander C. Humphreys, chairman, D. S. Jacobus, Edwin Ludlow and Comfort A. Adams. By the coöperation of these committees, a plan could be devised to bring about such a degree of standardization as will fit the present situation, and will prepare for future developments in further coöperation and standardization.

A. N. Talbot: Mr. President, it has been suggested that a brief reference to the results of a piece of coöperativev work of the Society, may be of interest at this time. At the request of Captain John Halligan, Jr., who at the time was the head of the post-graduate department of the United States Naval Academy, the Secretary of the Navy asked the president of this Society to appoint a committee to go to Annapolis and confer regarding the work of the post-graduate department. The Committee appointed consisted of Professor Swain, as Chairman, Professor Breckenridge, of Yale, Dean Bishop, of Pittsburgh, Professor Karapetoff of Cornell, and myself. A three days' conference was held at Annapolis in January, 1916. The work of the post-graduate department, which is separate from the academy itself in its organization, takes as graduate students naval officers who have been out from the academy from two to six years. The first year, or part of the year, is given at the academy. The other year or two years are taken at one of three or four engineering schools that are strong in the particular lines that these men are to study, mechanical engineering, electrical engineering, etc. Only the first year's work was considered by this committee. A number of recommendations were made by the committee in its report. The war came on before there was time to put these recommendations into effect. For obvious reasons, the Post-Graduate Department was discontinued during the war; the instructors in the department were set to teaching in the academy, and it was only about a year ago that the work was reëstablished. Since then I have had opportunity to know something of what has been done through Captain King, the present head of the post-graduate department. Captain King says that the report has been of great advantage to him and to the department. One of the recommendations contemplated a special building for the Department. The Marine Hospital Building has now been turned over to the post-graduate department, and it makes most excellent quarters for the work. They are also getting equipment which they need. There has been an increase in the teaching staff. Captain King reports that there are a number of matters in the report of the committee which he is taking advantage of and which he expects will be of value in in getting things done in the next few years. I think this reference to the results of the activity of a committee that was constituted by the Society may be worth giving as showing a by-product of the Society.

While I am speaking of the Naval Academy, I should like to make a statement concerning some changes in conditions at the academy, particularly as Dean Cooley referred yesterday to teaching methods there. Due to the increase in students, the number of midshipmen now being something like two thousand, and to the difficulty in taking a large number of naval officers away from naval duties, there have come changes in the nature of the teaching staff; there are now over one hundred civilian instructors, nearly as many as the number of naval officers in the instructing force. I am glad to say that the selection of these men, the method of selection, and perhaps the quality of the men in training, education, and later development, seem to be excellent. In the last two years changes have taken place in the status of the civilian instructors, in their tenure of appointment, their salaries, that is quite encouraging. Formerly the instructor was appointed without definite tenure. Promotion was uncertain and rather accidental, I judge, but now an academic rank has been given to civilian instructors, so that there are instructors, assistant professors, and professors with tenure of office and salaries corresponding with the rank; and while the salaries are not yet as high as they should be, they compare favorably with what is paid at other institutions of the country. I hesitate to speak of the matter of instruction. I think Dean Cooley yesterday must have been referring to what was done perhaps a generation ago, but as a member of

Board of Visitors I have had an opportunity to see something of the instruction there, and I believe real teaching is done. I am sure they have it in mathematics and mechanics, and also in physics and English and modern languages. I am not speaking of the aim of their teaching (it has not the same ideal as our college teaching), but for what the naval officers feel they want given to the midshipmen, the instructors at the naval academy are certainly making a great effort to teach, and it is no longer necessary for the midshipman to learn the best they can by themselves.

REVISION OF ENGINEERING CURRICULA AT THE UNIVERSITY OF MICHIGAN.

M. E. Cooley: Mr. President and gentlemen: A number of you know that we here at Michigan have had under consideration during the past year plans for revising our several curricula. A Committee report submitted last December has been under discussion since then by our faculty sitting in committee of the whole, so that the younger members could participate. One of the main results developed by the discussion is a strong sentiment in favor of a five-year course. The fifth year would, however, be optional. The Bachelor's degree would as now, be conferred at the end of four years, and the Master's degree at the end of five.

Some parts of the technical work now included in the four-year course would be transferred to the fifth year, its place being taken by more general studies.

The one feature of the plan which impresses me favorably is the utilization of what we call the " ribbon " system, as opposed to the " block " system. In the block system a subject, like English for example, is taken up and finished in comparatively short order. Another subject is then taken up and finished, and so on. The engineering courses do not get much of a start before the junior year. From that time on the work is largely technical. In the ribbon system the principal divisions of work are carried through the entire course, starting with the freshman class. This would include some parts of the technical work. The ribbon would embrace, say, (1) languages, and other literary subjects, (2) sciences, (3) mathematics and mechanics, and (4) engineering subjects.

It might be that instead of finishing English and modern languages in the sophomore year they would be a part of the work of the third, fourth, or even the fifth year. Nothing has yet been finally decided, but it is intended to set up the curriculum during the summer and present it next fall. The faculty will then have another opportunity for discussion,—the whole year if they want it.

To give a little idea of how our minds are working, let me introduce a few figures. Our present four-year course requires 140 hours of work to graduate. The term "hour" means one recitation a week, or its equivalent, for one semester. Just for the purpose of illustration, suppose we added thirty-six hours more for the fifth year, making 176 hours, and divide by four. That gives forty-four hours. If then our ribbon has four colors, say, each of them represents forty-four hours. There would be forty-four hours of literary work; forty-four hours of mathematics, including engineering mathematics; forty-four hours of sciences, and forty-four hours of engineering. There might be more or less of any one of them. The four colors would run straight through the whole four or five years.

At the end of the fourth year, the student would be graduated as Bachelor of Science in Engineering. Those who stayed the fifth year would receive the Master's degree. While the four-year man might not be as well prepared in a technical sense as now, he would have other things which it is believed would make him a better all-round engineer. In the fifth year he would complete the balance of the technical work and, presumably, some additional courses of a technical character. It is thought that, while at the beginning, there would not be a large number taking the five-year course, the number would gradually increase.

We have a five-year course today and it has worked surprisingly well. We are affiliated with Albion College and also with Olivet College. Some others are under consideration. The student takes at Albion College, or Olivet, three years of his regular college work. He then comes to the University and takes one year in engineering, on completion of which he returns to Albion or Olivet for his Bachelor's degree. On completion of his fifth year work with us he takes our Bachelor's degree. About thirty students have come to us from Albion in the last two or three years and they have done fine work.

In this affiliation the University has insisted that no engineering work shall be taught in the college. The college is free to teach any other subject, being careful to prepare the students in mathematics and the sciences and other subjects, which will enable them to carry on their engineering work when they come to the University. I believe the results of such affiliation will be very marked in the future. I have the feeling that out of that kind of an education will come a different type of engineer. We hope sometime to have a similar arrangement with our own literary college.

Please understand that what I have said about our revised curricula is in the nature of a progress report, nothing has yet been finally settled.

REPORT ON THE COURSE IN ENGINEERING PROBLEMS TAUGHT AT IOWA STATE COLLEGE, 1919–1920.

BY E. C. KIEFER,

Assistant Professor of Mathematics, Iowa State College.

Problems for first-year college students in engineering have been talked of and discussed for some years, and at various times articles on the subject have been presented before this society, but until recently very little has been done to actually put it into practice. Many of the ideas have been carried out at the University of Washington. Greater activity in this field have been shown since the conclusion of the World War, due to the marked success of the experiment in army training camps.

At the meeting of this society last year considerable was said regarding the work. In a paper by Dean Marston, of the engineering division at Iowa State College, he proposed to add engineering problems as a regular college course for freshmen. Accordingly, W. E. Duckering, formerly of the University of Washington and also Captain in the Army Engineer School at Camp A. A. Humphreys, Va., was secured to carry forward the work. It was my privilege to be one of the corps of teachers selected.

In the following paragraphs I will endeavor to outline the work as given this past year, and mention some of the proposed changes for the coming year. In no manner must it be supposed that this paper is an argument for either the methods used or methods to be tried, but rather a simple testimony without conclusions.

The purpose of the course is to develop the student mind along the lines of engineering activity, and also to more closely correlate the engineering college and allied departments. It is not proposed to cover a certain fixed amount of subject matter in a prescribed time.

The *engineer* is characterized by a fearlessness in the face of unfamiliar situations, a keen desire to meet engineering problems squarely, and a cheerful acceptance of obstacles. He is willing to assemble all relevant data and carefully use that data toward a useful end.

The *student* should be surrounded with an atmosphere which encourages initiative and self-reliance, the power of observation and judgment, persistence, accuracy, and thoroughness, and the habit of independent study and thought.

To stimulate the correlation idea the instructors for the course were selected from the several departments of the engineering division and two men from the department of mathematics. By such a selection it was thought the problems would be viewed from the standpoint of the general engineer, and so presented that no particular group of students would feel the course did not belong to them.

As often as seemed necessary a conference of the instructors was called at which each spoke his mind freely. It was the same in this as in other branches of teaching, to use the slang, "put it across" and retain the students' interest.

One three-hour session per week throughout the year was used for the course. Drafting rooms were assigned for the classes as far as possible, that the student might have sufficient room on the drafting table to lay his paper and other materials without crowding.

By means of concrete problems dealing with physical situations, it was possible to awaken the interest of the student and acquaint him with the engineering field of thought and activity. There are two types of problems; the study problem, in which the engineering situation and methods of analysis are presented as accurately as possible; and the drill problem, which is primarily for the purpose of training the student in getting results in the most economical and efficient manner. The student was not necessarily graded on the study problem work, but his papers were examined with a vew of giving him helpful suggestions.

Every main study problem was accompanied by a variety of short drill problems of a similar nature. Two methods of presentation were employed, one taking the study problem as far as possible, then halting to take up special points with drill problems, then proceeding to the main problem; the other method, taking up a series of fundamental drill problems, then turning to the main study problem to apply the drill exercises. In all cases the student was drawn into discussion and allowed a chance to speak or write his thoughts freely. Many times his ideas were false, but the main object was to get him to think and reason independently. Our problems were not "cut and dried" textbook problems that always come out nicely, but were of a variety of actual structures, some of which were good design and some poor, but all common enough to be understood by the average freshman. To be sure it was not supposed that these men would be able to analyze a structure, or be proficient in mechanics upon completing the course, but rather to get them into the frame of mind of the engineer. Only such parts were discussed as required but little technical knowledge.

All work was done on standard mechanics paper 8½″ × 11″. Margins were ruled on the top and each side. The upper margin was ruled into three sections and used for date, name, problem and sheet number. The right margin, about ¾″ wide, was used for index headings for the parts of the problem, and the left margin, from 1½″ to 2″ wide, was used for scratch work or computations. These computations were to be clearly shown so mistakes might be checked. The several parts of the problem were separated by horizontal lines extending entirely across the page and results specially indicated.

A medium hard pencil was used throughout the course, and sketches and diagrams made with the aid of triangles and scale and of such sizes as to be easily read. Accuracy was stressed as absolutely essential to their training as engineers and little or no credit given for careless work. Check methods were used whenever possible. Non-essential puttering was discouraged by leading the student through the problem by a logical and smooth route.

Marks' Hand-book for Mechanical Engineers was used for reference only and not as a text. By this means the student became familiar with a standard handbook early in his career.

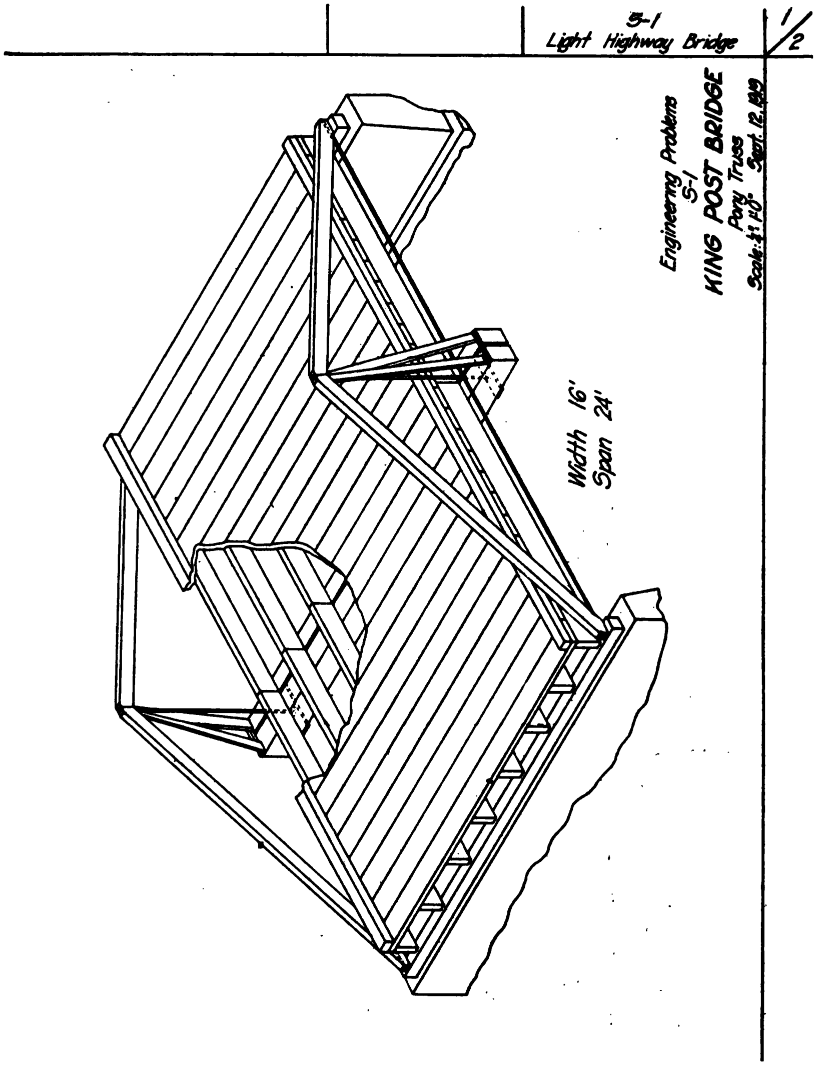
The first study problem was the investigation of a King-post truss 24 feet long, over a deep rocky gorge. This problem was long and bulky and had to be taken slowly as the great number of new terms such as, rigid-body, equilibrium, moments, resolution of forces, etc., were new to nearly all the students, and required comprehensive explanation.

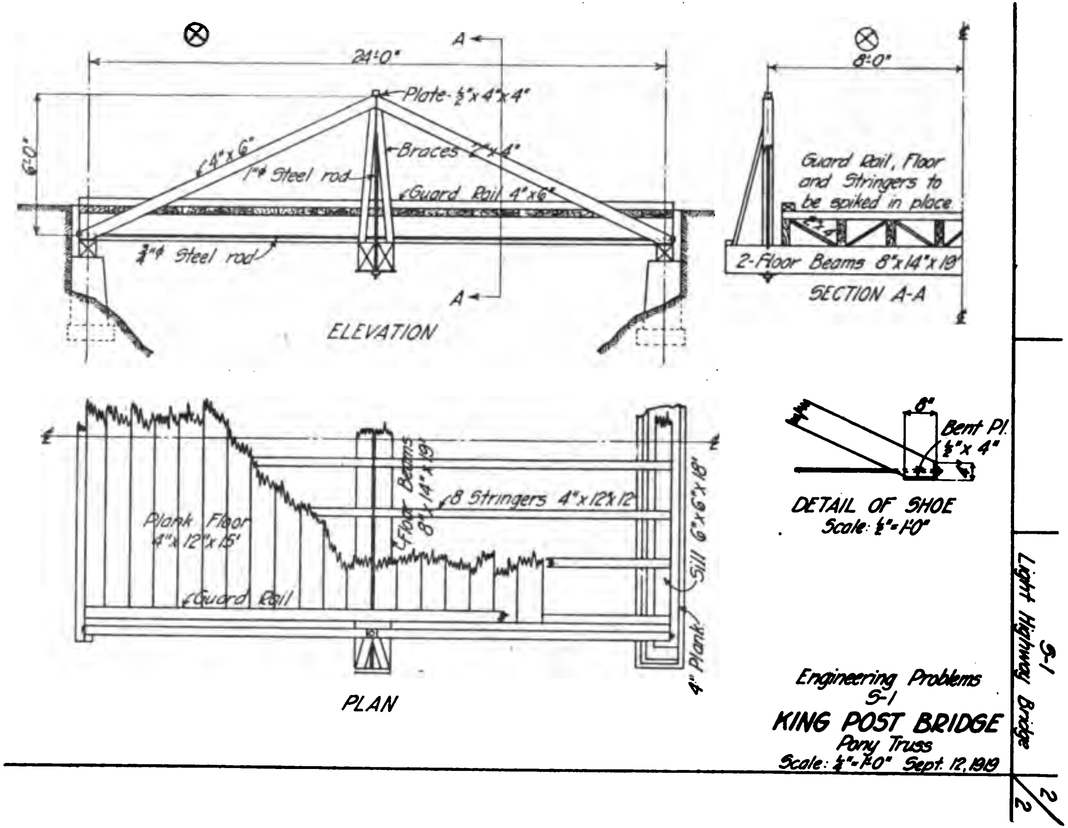
The specifications were given and sufficient drawings to enable the student to get an idea of the structure. A certain moving load was given to determine the safety of the various members of the bridge. As each member was taken up, its use was discussed, then the possible ways it might fail. If unsafe, how could it be made safe in the field? The actual computations were postponed until the discussion was well along.

When the hanger was analyzed the method of upsetting a rod for threading, to maintain its strength, was mentioned for the first time. It seemed that a new channel of thought was here introduced as most of the men had never given the matter attention as to how threads cut on a bar would reduce its strength, and they became more critical and were on the look-out for unthought-of flaws. Marks' Handbook on Upsetting and Thread Cutting was here used to advantage.

In finding the stress in the several members, the free-body sketch was introduced and discussed at length for use in subsequent problems.

When the end-posts were considered, the notion of compression on long and short columns of various cross-sections was discussed. Formulas commonly used in practice were taken from the handbook and used in this connection. The end-posts were found inadequate as specified, then again the


5-1
Light Highway Bridge
1/2
Engineering Problems
S-1
KING POST BRIDGE
Pony Truss
Scale: 1/4" = 1'-0" Sept. 12, 1909
Width 16'
Span 24'



24'-0"
6'-0"
A
A
Plate-½"x4"x4"
4"x6"
Braces 2"x4"
1"ϕ Steel rod
Guard Rail 4"x6"
¾"ϕ Steel rod
ELEVATION
8'-0"
Guard Rail, Floor and Stringers to be spiked in place.
2-Floor Beams 8"x14"x19'
SECTION A-A
Plank Floor 4"x12"x15'
Floor Beams 8"x14"x19'
8 Stringers 4"x12"x12'
Guard Rail
Sill 6"x6"x18'
4" Plank
PLAN
6"
Bent Pl. ½"x4"
DETAIL OF SHOE
Scale: ½"=1'-0"
S-1
Light Highway Bridge
2/2
Engineering Problems
S-1
KING POST BRIDGE
Pony Truss
Scale: ¼"=1'-0" Sept. 12, 1919

question was: how could they be made safe by the use of materials likely to be found in the field.

The lower chord was next in order for investigation, and at this point the students were thrown onto their own resources to a greater extent, as the mathematics and reasoning involved were similar to that already studied.

The matter of the safety of the floor-beams, sills, and planking was deferred until a later date, and was finally taken up near the end of the course.

The second study problem was to determine why a certain steel water tank on a wooden tower fell over in a high wind. This brought out a number of new mechanics concepts, some of which were, weight of water, wind pressure on flat and cylindrical surfaces, couples, equilibrium of rotation of forces in a plane, increased reactions and uplift due to wind, pressure on soil, and safety of concrete in bearing.

Here again a great deal of time was given to discussion, and the student allowed plenty of chance to express his ideas. Computations were started early in this problem, and as new ideas were needed they were taken up in detail and many illustrations used.

In general, the majority of the classes concluded the first term's work with this problem, although as before mentioned no particular amount of work had to be covered in a specified time.

The second term opened with the design of the proper cable for a mine hoist, operating with a certain maximum load and speed. This brought up the question of the selection of cable for this class of work, as explained in the handbook.

Here for the first time in the course the student was required to define energy, work, and power; and speed, velocity, and acceleration, then to note their proper usages.

After designing the cable, the size of motor and brakes were taken up in later problems and further clinched the physical notions of work and power. A number of problems of a similar nature were assigned and the students asked to do these, independent of suggestions as far as possible. When the brakes were considered the notion of friction was first introduced and discussed. Not being equipped with a knowledge of the calculus, the students were given some data regarding normal pressure on the brake-drum. They refered to the handbook for a formula in which Naperian logarithms were used. This gave them first-hand use of their training in logarithms and the solution of exponential equation.

Since the slide-rule is so commonly used by engineers, it was deemed advisable, at this time, to give them a grasp on the underlying principles and practice in its accurate use. The first period was devoted to constructing the *A, B, D* and *K* scales, on a piece of cross-section paper, then the *A*-scale was detached and used in connection with the other scales. Definite rules for determining the decimal points were given and put into use when the slide-rule proper was taken up. Accurate settings were exacted, but no fancy settings indulged in. From this time on the student was expected to use the slide-rule for computations, even though he complained that he could do it quicker by long-hand and be more certain of his results. It was accuracy and practice and confidence in results obtained that was desired.

No new subject matter was introduced in the third term's work, but the ideas of the previous two terms problems presented in new dress. Further stress was laid upon accuracy neatness, and logical reasoning. and many short drill problems on moments were studied.

As an example of the moment idea, the last study problem was the investigation of a concrete dam with respect to overturning about the toe, sliding on the foundation and rupture. The class was given freedom to do the problem the way that suited them best; and fair results were secured.

It has been suggested by members of the staff that the problems for next year be shorter, that is present only a few new ideas at each meeting of the class and get problems to fit the discussion, as the freshman is not ready to attack long difficult problems so early in his training. By shortening the problems, the student may be given more time to digest the new subject materials. It is further expected that the course for next year will be rearranged and so changed that one problem will not extend over more than two class periods, thus tending to encourage the student to do a higher class of work. Some have suggested shorter periods and more per week, while some have mentioned one 4-hour session per week; but in general the three-hour period seems to meet the present requirements.

Since the course is in the experimental stage it is hoped that later other schools may have something to offer as to their success and progress, from which we may all profit by the discussion.

PAY OF ENGINEERING EDUCATORS.

BY F. H. NEWELL,

Professor, Civil Engineering, University of Illinois.

Present Conditions.—"The most critical problem in engineering today is to obtain a sufficient number of competent teachers. The Society can undertake no greater task than to improve the condition and increase the emoluments of engineering teachers so that engineering students may all have instruction under men of thorough training in theory and practice who can comply with the specifications of a good engineer." This is the statement made by Professor Milo S. Ketchum in his Presidential Address given in 1918 (p. 31).

It is now two years since this assertion was made; during that time conditions have become worse; the characterization that this is "the most critical problem in engineering education" needs to be even more emphatically stated. It is hardly too much to urge that our system of engineering education is likely to lose public confidence unless effective steps are taken in the near future to improve the conditions.

In these two years, what have we done to meet this most critical problem! Have we, the teachers and exponents of efficiency, as men and citizens concerned with the public welfare, have we risen to the occasion and effectively acted in the emergency? Hardly! While efforts have been made in some places and there are exceptions which prove the rule, yet as a whole we have done little or nothing. We have even prided ourselves upon our patriotic devotion to the work and the bravery of our underpaid subordinates in sticking to their posts in spite of the fact that they have been getting into debt in order that they may comply with our urgent requests to continue their teaching.

Bravery or Timidity?—Here is where there should be critical self-examination and questioning as to whether we are doing the right thing in commending the under-paid men who have "valiantly" stayed by the work through these discouraging times. Let us look fairly and squarely into our own motives and attitudes and those of these men who are staying at less than living wage. Are they or we doing this from conscientious motives of patriotism, or through the exercise of bravery? Is it not rather the reverse? Are they not staying through lack of initiative? Have they not been too timid and too little accustomed to looking after themselves: Have they not feared to make a change and have chosen to endure present ills rather than fly to others unknown? Are they not justifying Bernard Shaw's jibe? Those who can, *do,* those who can't *teach.* There is nothing inspiring to the student in being taught by an under-paid man, one who is worried by his debts or by failure to secure a fair living. No one thinks of consulting such a man on ordinary business, or trusting to his judgment in the common affairs of life. He is regarded as a person who has chosen a relatively nice, clean kind of work, one where there is little demand or opportunity for initiative, and where he can spend his life jogging along a narrow path, without the difficulties or uncertainties of his brother who is out in competition in the business world.

The fact that he has acquiesced in receiving pay less than a living wage does not redound to his credit, nor bring to him any sympathy from the active man of affairs. While we condemn the profiteer, we also hold in hardly less esteem the man who undervalues himself or his goods, and is willing habitually to sell these at "less than cost." We properly assume that he is selling bankrupt stock or obtaining an equivalent reward in some other way. No normally constituted citizen believes that he is getting value received from men who are habitually offering their wares below cost, nor does the student have an awakening from the educator who sells his services at bargain rates. Sound public policy requires that the producer and the dealer each make a fair profit; and that the laborer, whether a farm hand or educator, obtain a proper reward, one adequate for the full support of his family under existing conditions.

Some Results.—As illustrative of some of the results which have come from this underpayment of educators it may be allowable to quote from the college paper of one of our largest state universities, one which formerly was reputed to pay salaries as high as those of any similar institution. In presenting the result of a canvass of the educators it states:

"The story of years of privation is told in the following short paragraph from the testimony of an instructor, recently promoted from the rank of assistant: 'Postponed marriage until 35 years of age. Worked two summers against advice of physician; use inferior grade of clothing; buy furniture at second-hand stores; live on edge of town to secure lower rent, thus making it difficult for wife to "go to things."'

"The startling fact that one half of the instructors, associate and assistant professors cannot live within their salaries and that one third of the professors cannot, reveals the seriousness of the situation. Restricting the compilation to married instructors, the percentage mounts to two thirds who are living beyond their means. Tabulation of the reports of assistant professors having more than one child showed that three fourths had greater expenditures than incomes.

"The story of how insufficient salaries are stretched to meet the growing demands of high prices and how the strictest economy is practiced by every member of the family, as it is told in the 'remarks' section of the report without the bitterness which such conditions would cause in any other group of people is a tribute to the 'heroism' of the University faculty.

"Privations mentioned by almost every faculty man who filled out the questionnaire are: a cutting down of food, either in quantity or quality; use of clothing after it is shabby, by all members of the family; postponement of medical services, often detrimentally; privation in books, magazines, music and travel, even to the extent of hampering progress intellectually; cutting down on amusements."

Following are some of the statements describing the above economies:

"Health of wife broke down following flu. Absolutely unable at University salary to give her the rest and comforts needed."

"Postponing dental and medical services because of insufficient funds."

"My chief concern is that I cannot save for the future or have the technical journals I should have or attend scientific meetings on my present salary."

"It has been impossible for me to attend many university or other functions of an educational or social nature because of lack of clothing and funds."

"We have been unable to purchase playthings which are essential to the normal and happy development of children."

"Entertainment of the commonest kind impossible; cannot afford membership in University club or other social organizations."

Reference may also be made to reports of the U. S. Bureau of Education and to official documents, also to articles in current magazines pointing out the unfortunate conditions of instructors in engineering colleges. In *The American Magazine* for March, 1920, is an entertaining article entitled "Snickers at My Second Hand Clothes" in which a college instructor, near the end of his rope, tells of his troubles in trying to live on inadequate pay, particularly in meeting the contemptuous remarks of his students, sons of former associates, or well-to-do citizens.

It is a question, however, whether these men really deserve sympathy. What they need is a guardian, for most of their complaints show a lack of plain common sense. The best thing that could happen to them would be probably to be thrown out of employment, to be forced to take account of stock and to go into commercial work where they could earn more and possibly acquire an ability to hold their own in the business world. Their main trouble arises from timidity, from lack of breadth of view and of experience in other than extremely narrow technical lines.

Dr. Ira N. Hollis, president of Worcester Polytechnic Institute, stated last year: "Administration may well be directed to one point and that is the payment of professors so that they may have enough to live on with leisure to think about their profession. That is a fundamental question before the American people. If it is answered properly, good men will turn naturally to the teaching profession instead of turning first to commercial positions as giving them a better chance to bring up their families. We have too many cases of poverty among teachers." (See his address of June, 1919, on "Engineering Colleges and Administration" in PROCEEDINGS, Vol. XXVII, page 75.)

Col. Anson Marston, dean of the engineering college of the Iowa State College, insists that engineering classes should not be turned over to cheap, inexperienced instructors, and adds "only mature engineers, well qualified as engineers by outside experience as well as by college training should be given charge of classes. The students are entitled to the inspiration and to the professional instruction outside of all textbooks which can be obtained only by direct personal contact with high class engineer professors throughout the entire four years of their college life. The cheap type of men often employed as instructors should be used only as assistants in preparing class material, in directing minor details of laboratory work and in correcting student drawings and papers." (PROCEEDINGS, Vol. XXVII, page 282.)

Underpayment.—It may be a very proper question to ask as to the attitude which should be held toward those men who accept compensation at a rate less than that which is considered as a standard or as proper to be paid for the character of work performed. In answering this question it is well to consider what is the attitude of other professions toward underpayment: such for example as the doctors, lawyers, and architects. Here there was earliest developed what is commonly known as "collective bargaining," in that certain rates of pay have been somewhat rigorously fixed and no man can remain in good standing who accepts a fee or rate of pay which is below that which is regarded as proper by the majority of the profession.

On the other hand, we may refer to the accepted attitude of organized labor which has never failed to enforce with equal rigor, but in a cruder form, its conception of the man who jeopardizes the wellbeing of others by accepting a compensation below the standard rate. There is little disagreement as to the resultant bad effect on the profession or on the trade, whichever it may be, of the men who accept and try to live on a rate of pay below the fair minimum.

Generosity of the Public.—The generosity of the public and of many of the engineering colleges in providing practically free instruction has been one of the sources of self-congratulation of our people. The question has been raised however whether this generosity is not resulting in a lowering of engineering standards or in lack of appreciation of a good training, inasmuch as students—like other persons—are apt to value a thing at what it cost. Free education is no exception. In this connection, the editor of *Engineering-News Record* (May 13, 1920, page 939) states:

"The significant fact is that hordes of graduates are being turned out to whom practically free instruction has been given. Who pays for this generosity? Is not too great a portion of it taken from the pockets of the instructors whose loyalty or a desire to retain work for which they are fitted, or perhaps for lack of salesmanship or business ability, stay on year after year at less than a living wage?"

To produce such generous treatment, the editor calls attention to the fact that in order to avoid a deficit in college finances all ranks of educators "have usually had to resort to most rigid economies and to cut far below any reasonable minimum the amounts allowed for savings and professional expenditures. As a natural result there is little room for that buoyancy and enthusiasm, that combination of free play and concentration of mind essential to growth and success in intellectual life (page 939).''

Do not however draw a wrong conclusion that to get good instructors we have merely to raise the pay. It is not to be assumed that mere increase in wages will convert a poor teacher into a good one, but assuming that the instructor is a man of fair ability, it is self-evident that this ability will be increased and made more effective by the increased self-esteem and self-confidence which comes from absence of worry about financial conditions. Moreover, the ability to procure the necessary tools of his profession, the larger appreciation by the public, and by his students, all add, within reasonable limits, to his efficiency in geometrical ratio. The debt-ridden instructor may expand into a true leader.

In public esteem, in any profession a man is apt to be measured by the amount of money which he receives. To a certain extent his opportunities for usefulness depend upon their amount, not only because of the money itself, but from the fact that the recipient has a higher standing and a wider influence wherever it is known that he is receiving large compensation. If he is earning a meager living wage and is barely able to pay his necessary debts, the public and especially the student body does not accord to him the same confidence nor listen to his utterances with anything like that respect which is aroused by the fact that the man who is giving the statement is known to be well paid.

At the present day there is the greatest need for engineering educators who can devote their energies and spiritual qualities toward creating a higher conception of humanity, building up the appreciation of the fact that for the public welfare we must have greater efficiency in the individual. As never before, it is the teacher's task and opportunity to lead the young engineer to see the dangers of the present situation and the fact that all must work more effectively if civilization is to continue. The engineer is the one man most needed to help increase production, for it is his claim that it is his business to produce for one dollar the results for which another man requires two dollars. If he, because of limitations of pay, cannot deliver this message, who can do it?

In the business world it is recognized that for success it is necessary to have contented, carefree and happy employees. How much more necessary is it in the expert quality of work required in the business of instruction. Good teaching perhaps more than any other activity is dependent upon a state of buoyant optimism; good teaching is a matter primarily of the spirit. Men can never do their best work as engineering educators when dispirited, worried, or depressed.

Demand for Graduates.—But it may be objected, the product of our colleges, even with underpaid instructors, must be good, for at the present time there is a demand for graduates such as has never been equalled in the past. There are literally two or three places offered from which each graduate may choose. Prospective employers are sending their experienced representatives to the colleges to try to induce the graduates to enter their employ. They are offering these new and untried men more than their experienced instructors are receiving.

Through this anxiety we might infer that engineering education is in great demand, and be misled by the belief that it is the education rather than the man which is being sought.

An analysis of the demand indicates, however, that the employers are not particularly concerned about the education received, or its kind. They may be taking the men in spite of, not because of, the education they have been receiving. The employers are looking first to the qualities which have been described by Professor Charles R. Mann as being those not taught in the engineering colleges, but are matters of character which have been acquired or developed largely outside of the college. It is the man rather than the engineering education which is valued. As a matter of fact, few of the employers inquire as to what particular course has been pursued, or what studies taken, or as to the standing of the student in the college except as incidental to obtaining a side light upon the characters of the graduates.

It is of great importance to us to clearly understand what are the things which the prospective employer looks for in the young man. First and foremost he notes carefully the general outward physical appearance, vigor, strength, and more than anything the general attitude, whether self-possessed and generally attractive. He passes over some of the more scholarly instructors who are getting low wages, and makes an attractive offer to the graduate who so far as book learning is concerned is inferior in scholarship. It is the man he is looking at.

Other Occupations.—Because of the conditions above described many of the best instructors, the men who have been most successful in conducting classes, finding that without outside income or work they cannot support their families have been forced to leave the occupation to which their life has been devoted. They have gone and are rapidly going into industrial and other pursuits simply because they must earn enough money upon which to live. Thus the more energetic or vigorous of the younger men have literally put on the over-alls of the artisan or the high-grade mechanic and are able to earn twice as much money as they did while instructing. This results in lowering the average value of the remainder of the group, it produces the type regarded by students and the public as being impracticable or inefficient in ordinary affairs.

Menace to Welfare.—The conditions above described form a menace to public welfare as well as to the engineering profession. For the teaching staff of the engineering college to consist in part of underpaid educators tends as just stated to lower the whole body and strikes at the foundations of the engineering profession.

"A thousand experienced educators of young engineers have gone on strike! Their places have been filled with less well qualified men." This is a claim—confidently made—not based on accurate data, but on general information, for there is reticence, bordering on secrecy, in the matter. Nor is the strike open, organized or spectacular; on the contrary it is the individual withdrawal, discussed only in personal letters, and forced by the hard facts that the pay of these educators—barely sufficient in the best of times—has shrunk to the point where one man after another—without mutual understanding or concerted action—has left his chosen vocation. In some cases in mechanical engineering as just noted he has taken off the white collar and pulled on the over-alls—doubling his pay by so doing.

What is the result? While the individual does gain in his ability to provide for the wants of his family, what happens to the educational institutions? There is only one answer: the value of the instruction is lowered, the output in student efficiency is diminished. The engineering profession first and later the public suffers a distinct loss.

What is to be done? If it is a fact that the public is bound to suffer loss from inability to get and maintain good engineering instructors for the new generation how shall we meet the situation? Shall we simply sit back and discuss it, deplore the action of the law of supply and demand or shall we plan wisely and act energetically to put into operation other forces which will tend to rectify existing evils?

What Sets Salaries.—It is claimed that these wages cannot be changed, that the authorities in direct charge are limited by laws or that the amounts offered are set by the "immutable law of supply and demand." It is urged that no improvement can be made. But is this any more true than the claims from time immemorial of all employers? For example, the cotton-mill owners in past decades have asserted that they were compelled to pay starvation wages to women and children and to work them fourteen hours a day in order to keep up the industry. History has disproved this claim, and the hours and conditions of labor as well as of pay have been adjusted by other forces which have been more potent than the law of supply and demand.

What does set the wages of an engineering educator? On this point we may well consider the statement by Royal Meeker, the statistician, in his paper before the American Economic Association, December, 1919, where he states:

"If there is an economic law working uninterruptedly to adjust the economic reward of each member of society in accordance with his economic merit, or in other words in proportion to his contribution to the economic production, it remains hidden beyond the ken of statistician and administrator."

"Practically the pay (of the engineering educator) is determined by his bargaining power"—or salesmanship. The forever present question of compensation really rests upon bargaining power of the group of men here present, or of this organization. If engineering educators as a whole are underpaid the fact is due more to their lack of skill in bargaining than to the law of supply and demand.

Supply and Demand.—The law of supply and demand undoubtedly has about the same relation to the wages which are paid as does the law of gravity in its control of the operation of a railroad. There is no question but that gravitation is at all times effecting the operation of trains, but this effect is concealed largely by the action of the motive power, which, applied as needed, exceeds or overcomes the immediate effect of gravity. In the same way, while the law of supply and demand is operating all the time its immediate effect is being modified by other laws, notably the demands of the people concerned and the effect of these on the general public as well as by the long-established habits. A certain rate of pay, having been acquiesced in during a long period, now has an almost binding effect.

If you wish to offset this condition it is obvious that you must set in motion other motive powers which must be wisely and continuously applied. In order to overcome inertia and the present ill effects of the law of supply and demand, you must aid in developing by well-considered action, largely by education of the public, such modifications of the supply of engineering instructors and of demand for the kind and quality of service as shall provide for present needs. The bargaining power of the individual educator must be increased. To do this his self-respect and his regard for the profession must be raised. You must enable him to acquire the proper confidence in himself and in his fellows such as will result in his dropping the apologetic air of the undervalued man.

Living Wage.—But what are the needs of the educator? They may be summed up in the expression "a living wage." Every man should receive sufficient compensation to permit him not merely to exist, but more than to perform effectively certain activities. This is particularly true in matters of engineering education.

The Bureau of Labor Statistics at Washington has advised the Congressional Committee on salaries that in the city of Washington the lowest possible amount upon which a man and a wife with a normal family of three children can get along is about $2,250 (*School Life,* December 1, 1919, page 8).

In comparison with this the average salaries of 6,600 college educators, including engineering instructors, is about $2,000. This average includes a considerable number of relatively high-paid men.

When this amount is compared with the reduced purchasing power of the dollar, which is shrunk on the basis of 1913 prices to less than 50 cents, it results that the man who received a wage of say $2,000 in 1913 and whose salary has not been increased is now trying to live on the equivalent of $1,000.

The budgets of faculty families made in 1918 showed that: the excess of outgo over income, or the average deficit per individual in the family, was about $200—that is with a family of parents and three children, or 5 in all, there had to be outside earnings or income of about $1,000. To put it in another way the professor or assistant is paying about $1,000 for the privilege of trying to make a living at teaching, assuming that he could earn a living wage at some other occupation.

While many engineering educators possessed of the missionary spirit will continue to teach even under these adverse conditions yet as before stated the more able men, tempted by correspondingly great increases in commercial activities, have left the field, greatly lowering the average value of the services performed. Even though instructors do stay, there is such restlessness and frequent shifting about as to impair the organization.

What is the amount of money which must be paid to engineering instructors to keep the efficient men "on the job." It is obvious that whatever may be their devotion to their work they must receive enough compensation to enable them to purchase the necessities of life and to have a few comforts.

It is not usually expected under present conditions that they will have a salary comparable to the rates paid in some of the more highly commercialized occupations. At the same time the difference must not be so great as to keep out of the teaching profession the type of men who are most effective in producing results.

Base Salaries.—In considering adequate pay it is necessary to have some base level or par value from which there may be a departure, either above or below par, to meet the varying conditions. This base level, like ocean level, is needed as a plane of departure from which we may measure the heights of success or the depths out of which the beginner must climb. It should be equivalent to the living wage, that is to the amount upon which a man who devotes his entire time to the profession can find support for himself and his family.

This base level of salary or par value for the ordinary or most numerous group of unskilled or as yet not fully experienced engineering educators should be in accord with the social conditions or surroundings under which a college man can live and maintain his self-respect. It must be adequate to furnish a living for the ordinary American family and under usual conditions of life suitable to the welfare, mental and physical, of the employee.

Whatever the value of the work may be, it is obvious that, for public policy, the man who devotes his life to the work must be compensated to a degree sufficient to hold him, and to enable him to support a family in proper comfort. If the work is not worth the salary or wages adequate to furnish a good living then it should be discontinued.

In the case of the engineering profession the minimum or base salary which is barely sufficient for the support of a small or young family may be placed at $2,000. No young engineer should attempt to devote his entire time to his work for less than this amount. This may be considered as the base wage since for full-time employment the salary must provide:

First, a living for the worker and his family.

Second, if the occupation is to be solvent or a going business, it must make provision for old age.

Third, there must be suitable relations to the cost and difficulty of the preparation involved.

Fourth, some consideration must be had of the value of the services rendered to society. (Hollis says: The value of a teacher's work is very rarely measured by his pay.)

Fifth, there must be provision for continually attracting and holding men in the well-developed organizations, stimulating them in their highest efficiency, with a view to increase of quantity and quality of production.

Below Base Level.—Reduction of the money wage below the base salary may be considered whenever in addition to money-wages other valuable consideration is received. For example, the work of an assistant instructor may be performed by a recent graduate from college who desires to perfect his education or to gain experience along certain specified lines or to conduct research which may be of real value to him. Under such conditions it is allowable to set a money value say of $25 or $50 per month upon this experience or education as a deduction from the base level, but care should be taken to see to it that this real value is truly received and one which will definitely add to his earning capacity. Experience that does not thus definitely add to his ability to support his family and which merely adds to his theoretical, non-financial value should not be considered as an offset to a full salary.

Great care should be taken to provide safeguards that this reduction below the base wage is fully compensated by a real tangible value, and not be simply a matter of gratification to a person who has other sources of income.

The acceptance of less than a living wage by persons who are able to subsist from other income should be frowned upon as being adverse to public welfare, and as tending to lower the necessary living wage of the kind of men who are needed in the teaching profession, and who will suffer directly or indirectly through such competition and consequent lowering of a fair wage scale. The argument is occasionally made that young unmarried men should be offered a less salary for the same work than a married man. Sound public policy, however, is against such an attitude.

There is danger of giving too much weight to the fact that the engineering instructor does receive compensations other than money. The fact that the instructor receives steady pay and that he has no worries as to the collection of his salary or wages may properly be considered. His position is sheltered, he is not subject to continual attack, as is the case in many other conditions of labor, nor does he lose a large amount of time on account of weather or climatic conditions. But the extent to which this may be used as a deduction or offset from what would otherwise be considered a fair compensation is a matter to which careful thought must be given. The tendency has been to exaggerate the importance or value to the young instructor of this routine work or sheltered life, and to reduce his pay unduly.

Increase Above Base Salaries.—The increase above the base salary should be by stages or steps relatively small, but taken at short intervals of one or two years. The advance should be at the rate of $150 to $200 per year for effective service and should be continued to the time of assistant professorship. Above this point, the spread should be greater and the steps longer so as to clearly mark out the man of distinct ability.

There should be a few large prizes in relatively high-paid professorships, stimulating the younger men in the hopes that they may receive the highest reward attainable by professional men. Advancement to these should not be made on the basis of seniority.

Outside Earnings.—During the past few years it has been necessary for the engineering educator who has acquired the responsibility of a family, to seek some means of adding to his regular income by activities outside of his teaching profession. In many instances the wife of the professor tries to assume a part of the financial burden by doing work beyond the confines of the home.

Most of this outside work is undertaken during the summer vacation. In many instances such employment is desirable, particularly if the work is along professional lines. It is however quite difficult to secure work of this kind which gives valuable experience and which at the same time is sufficiently remunerative to make up for the losses or deficit in earning as compared to expenditures during the teaching period.

Some of the engineering colleges require that an engineering instructor spend more or less of his time on professional work outside of the classroom. Others take the opposite course and forbid outside work being done for pay. All adopt the principle that any occupation of this kind which is undertaken must not interfere with the regular work of the college.

There is no question but that it is necessary for an instructor of engineering to keep abreast of the times and to be in touch with practical men and affairs. If this is done, however, not so much for the purpose of increasing his teaching ability, as it is to obtain bread and butter for the family, the result can hardly be expected to be wholly satsfactory.

Some of the evils flowing from the outside work have been noted by Dr. Ira N. Hollis who states regarding textbooks:

"Our books are usually slip-shod, prepared at odd hours, between the preparation of lectures and the practice of consulting engineering, simply because our teachers have been encouraged to supplement their insufficient salaries by outside work.'' (PROCEEDINGS, Vol. XXVII, page 80.

A. A. E. Committee.—The needs of engineering educators have been given consideration by the American Association of Engineers. This organization has already developed certain standards of pay for engineers in the employ of railroads, municipalities and other public bodies. It has designated a committee, of which Prof. C. J. Tilden, of Yale, is chairman, with sixteen members selected from various parts of the country and representing men in private practice as well as college professors. These are as follows:

Prof. Frederic Bass, Minneapolis, Minn.
Dean F. L. Bishop, Pittsburgh, Pa.
Mr. Baxter L. Brown, St. Louis, Mo.
Dr. S. P. Capen, Washington, D. C.
Prof. P. H. Daggett, Chapel Hill, N. C.
Mr. Harrison P. Eddy, Boston, Mass.
Prof. C. G. Hyde, Berkeley, Calif.
Mr. C. H. Hubbell, Detroit, Mich.
Mr. A. N. Johnson, Chicago, Ill.
Dean Anson Marston, Ames, Iowa.
Mr. George C. Mason, Portland, Ore.
Mr. R. E. McDonnell, Kansas City, Mo.
Mr. A. H. McKeen, Omaha, Nebr.
Mr. H. Z. Osborne, Jr., Portland, Ore.
Prof. Geo. F. Swain, Cambridge, Mass.
Mr. D. L. Turner, New York City.

This committee made a preliminary report to the annual convention of the A. A. E. at St. Louis on May 11, and has submitted this to subcommittees formed in each of the engineering colleges of the country. There has been great interest shown throughout these colleges and over 80 have appointed such sub-committees.

The recommendation of Professor Tilden's committee is substantially that the full time assistant-instructor, whose wages may be considered as forming practically the base level, should be from $1,800 to $2,400 dependent upon the varying factors as to size and importance of the institution, its location in city or county, and the scope and quality of service expected.

The next grade, that of instructor, teaching sections under general supervision of the professor in charge, is from $3,000 to $4,000.

The third grade, that of assistant professor, of which there may be several divisions, and who has charge of a laboratory or of individual courses of study, should be from $3,600 up.

The associate professor or junior professor, a younger man in line for a professorship, and in general capable of doing the professor's work, should have at least $4,000.

The full professor, a mature man with experience both as a teacher and in the practice of his profession, and in charge of courses of study, should have at least $5,000.

The professor in charge of a department, reporting to the dean or president, and responsible for the conduct of his department, should have a minimum of $6,000.

Col. Anson Marston, dean of the engineering college at Iowa State College, writes: "All prices are now on an extremely high level, and many thinkers believe that the world's prices will be much higher permanently in the future than in the past. A great shortage of engineers is now adding strength to meritorious organized efforts of engineers to put engineering remuneration on a fairer basis in comparison with bricklayers, carpenters and locomotive engineers. The engineering schools must compete in open market with employers of practicing engineers. The writer believes that salaries of engineering professors ought to be 50 per cent. to 100 per cent. higher than the average in 1916, provided that engineering professors are held to merit and to time requirements in their daily work as strictly as if working for outside employers. (See his article on "The Effect of the War upon Engineering Education in the United States," PROCEEDINGS, Vol. *XXVII,* page 281.)

Standard Salary.—A salary scale of this kind should be carefully considered, and formally adopted by this and other bodies of representative engineering educators and by societies of practicing engineers. Such a standard wage for engineering educators, including instructors, assistant professors, and full professors, who are teaching various branches of engineering, is urgently needed. It is necessary in order that the public in general, and particularly the governing boards of engineering colleges, may have something by which to measure the kind of men they are getting and keeping.

Without some such basis or common ground to start from, all discussions of relative rates of pay become vague. It is impossible to measure present deficiencies or future needs. By having such a standard, to which to appeal it may be possible to bring about a change in the attitude or customs which have the binding effect of law and which control the rates of pay. When such standard has been adopted, and when the sunlight of publicity has been turned upon the dark corners, it will then be possible to create or modify public opinion in such way that the old or obstructive attitudes may be altered, and wages may be adjusted to the present living requirements. It is obviously impossible to obtain the support of public opinion until there is a general agreement among well-informed men as to what are the present conditions, and what they should be. It is inadvisable to attempt to make any general change until the full facts are available and clear-cut statements can be made as to the rates of pay which will produce the best results.

By having a fair or necessary salary scale agreed upon the next thing to do is to ascertain to what extent each engineering position is above or below par, as related to this standard scale. Comparisons of colleges are now being made on the basis of the number of hours taught by each instructor. In the same way comparisons should be made as to the compensation received by each instructor, not that the value of the man can be directly determined in this way, but the comparison of the pay received has a value, similar to that brought out by a comparison of the number of hours taught and the number of different subjects given by any one instructor. If the instructor is receiving less money than is usually paid for work of this kind and at the same time is carrying an overload there is a reasonable presumption that the instruction given cannot be fully effective.

Whenever it is found that any particular salary is far below the base level or standard, inquiries should be made as to the conditions, and an explanation sought as to the causes on the assumption that it is a matter of common concern that engineering educators be properly paid, this being one of the fundamentals of efficiency in education.

Summary.—1. Engineering instructors, to be successful, must have a large measure of the spirit of self-sacrifice, and of unselfish devotion for the good of their students. In this respect they do not differ from all high-minded men in every profession. Personal comfort and gain must always be kept subordinate to the large duty in hand.

2. Because of these ideals, however, the engineering educator should not permit himself to become the victim of his own devotion, nor, through lack of common sense or wisdom, encourage or permit the public or his employer to take advantage of his interest in the work.

3. We can well praise the physician who puts aside his own personal comfort or gain and freely gives his services without hope of reward to benefit a person financially unable to pay for the services rendered; but if he should do this habitually for the well-to-do public, and deliberately deprive his family of necessities, our admiration changes to doubt.

4. The engineering educator in America is employed, as a rule, by organizations which represent the richest states or people of the world. They are of course, habitually short of funds, for in any healthy organization the needs and opportunities surpass any possible income. Nevertheless, there is no valid reason why the work which is undertaken by these institutions should not be well done and well paid for.

5. The public demands that the output of the engineering colleges shall be of the highest possible quality. A cheap product is not wanted, nor do people have confidence in the quality of the product turned out by cheap men. As between two engineering instructors of presumably equal ability and devotion, far more weight will be placed upon the results attained by the $4,000 man than by the $2,000 man.

6. However we may deprecate the matter, the fact is that personal services are valued largely in proportion to the amount paid for them. There is little or no respect held by students or business men for instructors who are willing to accept less than a living wage.

7. There is no reason why engineering instructors should not be able to live under the same economic laws as other citizens, expecting and receiving a salary commensurate with the needs of their families, and comparable with the value of the services performed.

8. It does not redound to the credit of the engineering instructors and to their organizations that they have failed to recognize and meet this condition of underpayment, especially of the lower grades. They cannot teach efficiency in engineering practice, nor inspire confidence in their teaching when they themselves are daily conscious of their own economic failings. They know that the students have little regard for the shabby, debtridden man no matter what his theoretical attainments may be.

9. The world respects success; it listens with indifference to excuses for failure. It measures success, unfortunately perhaps, largely in terms of dollars, or at least in ability not only to do something useful, but at the same time to support a family in reasonable comfort and free from debts. The man who in his devotions or absorptions in his daily work fails to provide for his family defeats the very object for which he is working, sacrifices the confidence of others, and thus loses his opportunity for wider usefulness.

10. Education is no longer an experiment, its value is es-

tablished. A safe investment which nets big returns should be oversubscribed. Past policy of overmodesty should give way to a campaign for financial support for education commensurate with its value.

11. As a fundamental proposition, it should be universally accepted that every engineering educator is entitled to a living wage from the instruction which he gives.

12. He should not be compelled to seek outside employment, or income from investments, or to depend upon the efforts of members of his family, to enable him to secure a living.

13. At the same time, it should be recognized that a small amount of outside work in the line of his profession is desirable, not as a necessity to supplement his living wage, but as a means of improving, or maintaining, his knowledge of the subject which he is teaching.

14. When it becomes necessary to seek outside employment for the sake of the remuneration, then the choice of occupation is usually limited, and the educator may be deprived of the experience which is needed in his educational work.

15. Salaries should be expressed in terms of purchasing power. Provision should be made whereby any reduction in the purchasing power of the dollar is met by an immediate and adequate increase in salaries as expressed in dollars.

16. A living wage for an engineering educator should be adequate not merely to furnish the absolute necessities of life, food, clothing, and shelter, but also to cover proper contributions to charities and to altruistic efforts, to provide some simple pleasures and to enable the educator to set aside a small sum, at least twenty per cent., for the contingencies of sickness or old age. Any amount less than this can not be considered as a fair recompense for the time given to the work.

17. It is opposed to sound public policy for an engineering educator to seek or accept a salary less than a living wage or below that paid for similar work. Even though a man may have another source of income or, being unmarried, may be able to exist on a smaller income, yet the acceptance of a

less wage, for any such reason, tends to lower the proper compensation to other educators.

18. It is a menace to public welfare, and to the engineering profession for the teaching staff of the engineering colleges to consist of underpaid, incompetent educators.

Conclusions.—If we agree with Professor Ketchum's statement with which we began, and with the general facts just given, it goes without saying that we individually and collectively should take action. The promotion of engineering education becomes impossible unless these fundamentals are given proper attention. Individually, we can support the efforts of the American Association of Engineers. Collectively we can endorse the standards proposed by Professor Tilden's committee and give it the widest possible publicity. We can draw comparisons between this and the actual conditions which exist in various colleges, encouraging the efforts of those institutions which are trying to establish and maintain proper rates of compensation. Unless we do take some definite steps and "speak for ourselves" we can not expect the support or sympathy of the public. By viewing the matter squarely, by taking action definitely we will raise the standard of engineering education and carry out in the most definite manner the objects for which this organization has been formed.

DISCUSSION.

C. J. Tilden: Mr. President and gentlemen: The Committee of the American Association of Engineers to which Dr. Newell referred, is in the midst of its labors. Perhaps I can say a word about the basis on which it was chosen, and the methods that we are following out. The Committee comprises seventeen members who are chosen partly from geographical considerations, and partly to get a fairly even balance between practicing engineers and engineers who are engaged in teaching service. There are representatives from the south, the east, the middle west, and the Pacific coast. With one or two exceptions, they have taken hold splendidly in attacking the questions on which we have to report. As an auxiliary body, the deans of something over a hundred large institutions were asked to serve as corresponding members, and we have received some very interesting letters from those gentlemen. A substantial majority approved in general this tentative schedule which appears on page 18 of Dr. Newell's paper, but with such comments as indicate that it has been carefully considered in every case. There are a number who have opposed it. Some say that it is considerably higher than it is possible for many institutions to pay, and that it would lose force if put forward as a committee report, simply because of the impossibility on the part of such a large number of institutions of meeting the scale.

Some suggest it be scaled down ten per cent., some twenty-five per cent., some forty per cent. Some make slight modifications. One or two men have suggested that the maximum salaries were not high enough. In no case, however,—and this is a rather important point,—out of some fifty odd replies that have come back so far, in no case has any university executive suggested that this scale was not a fair pricing of the services. The criticism is always based on the inability of the institution to pay, and that, of course, goes right back to custom. A college has, as a rule, a certain definite amount of money, a fixed income. For that income it has been accustomed to do a certain amount of work, to have on its payroll a certain number of teachers. Now, the suggestion is made that a great many institutions cannot meet any such scale as is here suggested, the salaries are too high, and, therefore, if you put out such a report it will not be generally accepted. That is from a small majority of the deans, because, as I say, most of them approve it. I want simply to call your attention to the fact that not one of them has suggested anywhere that this pricing of service is too high, that the service rendered is not worth the figures stated here.

This first scale was made by a member of the committee. Mr. A. N. Johnson, and myself, and it was based approximately on the principle of adjusting salaries today to the present purchasing power of the dollar, taking the salaries in 1912, 1913 and 1914, and considering what they would purchase, and then adjusting them so that they would purchase about the same amount under present economic conditions. There was no attempt made to boost them, but simply to meet, if possible, those conditions.

The Vice-President: Gentlemen, the subject is of sufficient importance to have a few minutes of general discussion. Is there any one here who cares to add to the subject of Dr. Newell?

Frederic Bass: I would like to suggest that this topic implies another form of coöperation with the national engineering societies. I presume that all the members here present are fully acquainted with some of the important recent developments and expansions of the national societies in their field of work. Before the founding of the American Association of Engineers in 1915, the societies busied themselves almost entirely with technical questions, and they are in this way acting still as educational institutions. The S. P. E. E. has a common field of effort with them for that reason. Some five or six years ago, this association of which Professor Newell speaks, the American Association of Engineers, was formed in Chicago, by a body of very young men who felt the pressure of economic conditions. They felt that the engineer in practice was not succeeding as he should. The organization started with men who realized that in the engineering profession there were a number of problems; not only this one of compensation, but many other business, economic and social questions which should be taken up and discussed from the engineer's point of view; they proposed to form a society which would work along those lines, and they went to it and have continued that course of action, and today the Association has twenty thousand members all over the United States, the largest engineering organization in this country and in the world, although it is a very young one.

It shows the force of the ideas which brought them into existence.

Now, in the last few years, the national technical organizations, the great engineering societies of the country, have also undertaken to do a good deal of this same sort of work, and you are familiar with the recent conference in Washington, the attempt to bring together all the engineers in the United States into one organization. It is one of the most significant events, I think, in the history of engineering in the United States. It is something which promises greater things. At that conference, one of the two great problems that were presented, and emphasized, to be dealt with by the engineering profession, was that of engineering education. It is obvious why this was done. The engineers of the country are beginning to see that they are interested not only in their immediate future; there is an idea of permanency that has crept into their thought; the idea that the engineering profession is something that is destined to play a greater part in the coming century than it has in the past, and that if the engineering profession is going to be what it should be, then the engineers of the future will have to be properly educated, and if they are going to be properly educated, they must have the right kind of teachers, and if they are going to have the right kind of teachers, these teachers must have adequate compensation.

At this conference, the American Association of Engineers, which Professor Newell represents, pledged its support to any proposition and to any efforts which this Federation of National Engineering Organizations might chose to inaugurate, so that we have the situation that the organized engineers in the United States are interested in several major problems, one of which is education, and I wish to again say that this paper presents another very practical phase of coöperation which this society might well take up with the great engineering societies of America.

RELATION BETWEEN TECHNICAL SCHOOLS AND INDUSTRY.

C. S. COLER,

Westinghouse E. and M. Co., East Pittsburgh, Pa.

Mr. Chairman, Ladies and Gentlemen: I have been asked to say a few words about the relationship which exists or should exist between the technical schools and industry. In the past the relationship has been what might be called a "step fa(r)ther." The schools have considered it their job to train men; the industries have attempted to take those men who have been trained and adjust them, in the quickest way, to their actual needs.

From looking over your program and after talking with a number of educators throughout the country, it is apparent to me that the time is rapidly approaching when the relationship between the technical schools and industry will be much closer, when we shall come to realize that our problem is a mutual one, and that there must be a closer understanding of all the facts involved in the industrial problem on the part of both the schools and industry.

In thinking over this matter while coming up on the train this morning it has occurred to me that there can be drawn a very close analogy between our various institutions in this country and a mechanical system of inter-connected fly wheels. We have our school fly wheel, our church fly wheel, our army and navy fly wheel, our industrial fly wheel, our commercial fly wheel, and a number of large and small fly wheels, all connected together in the same system. Any action on the part of one has its effect on each of the others. Starting with this conception, that there is a definite connection between the various units in our society, let us analyze for a moment the industrial fly wheel to see if the correct principles have been worked into the design; whether or not we are using our facilities to the best advantage and by what means we can increase the size of our industrial fly wheel and still keep it safe. (Turning to blackboard.) As the basis of our industrial fly wheel we have the hub, which I believe can be compared to the home. Without good solid home life none of the fly wheels in our system will be safe or worth while.

Considering next, the rim, we find that the elements which compose its structure are those individuals who have the intelligence, training, and practical experience, which carry the most weight in industrial life.

As far as industry is concerned the time of many individuals between the hub and the rim, is more valuable in study and preparation than in industrial work. This is the school period. However, there are always those who will enter industry with a relatively small amount of formal preparation for it.

Work is the real substance of industry. It should start in the home, being maintained and encouraged throughout the school period, and carried out into the rim of the wheel in conjunction with trained intelligence which gives it direction. It is impossible to take an individual from a city home and put him at a desk in school anywhere from 8 to 16 years and then expect him to go out into real industrial work, roll up his sleeves and enjoy doing things. The spokes of the industrial fly wheel consist of the actual work which students do in school and these spokes must be maintained to furnish a strong connection between the rim and the hub.

Once in a while out here in the rim we find a blow-hole, some one who gives up all his time to study and never performs anything. Sometimes we find a large amount of really good material crowded in near the hub where it is not very effective. Our industrial organization should be flexible enough to allow a man with intelligence, training, and aptitude, to work his way through the structure and out into the rim where he belongs. If elements are present in the rim, which do not belong there, they should be thrown off or in the end, if present in large enough quantities, they will wreck the machine. On the other hand the design and structure of the industrial fly wheel should be rigid enough to withstand the shocks that come to industry, to be able to slow down and start up rapidly, and to be always ready to render service in supplying human needs.

I have gone into some details in this analogy as I wish to bring out the very close relationship that should exist between the engineering schools and industry. They are both a part of the same fly wheel in our national organization.

Now to get down to special lines of coöperation which may be drawn between the technical schools and industry. First the student-selection is a fundamental thing both from a standpoint of industry and from the standpoint of our schools. Fundamentally the schools do the selecting of the high-grade material that is to enter industry. We, in industry, should supply the technical schools with information as to what is required of engineers, so that they in turn can go to the high schools and select the right men for training. Since the college entrance requirements determine, to a great degree, the character of our high schools, I believe that the engineering schools of our universities should have more influence than they do in establishing college entrance requirements.

If the instructors in our schools would study their students more carefully and would grade them, not only on the amount which they have learned, each term, but on their personal characteristics, the benefits would be very great. The effect would show up not only in aiding the student to enter the proper line of work but also in the ability of the instructor to secure better results through his knowledge of the individual students.

I agree with the member, that the students should be brought earlier in touch with the industry. Youngsters should have the opportunity to go through various plants and see the wheels moving, and to secure some impressions which will enable them to decide what they would ultimately like to be.

A year's work in industry, following a high-school course, would be a good thing for many of the students. Of course there is the danger that they may not wish to leave industry to continue their school work but at the same time many college students are working at a very low power factor because they do not know why they are in college and they do not have a real plan. A year's hard work in the shop would show many of the students pretty well what they ought to get out of their college work, not how to get out of it.

Summer work offers a definite line of coöperation. Industry has its problem, however, in absorbing large numbers of men for short periods of time. There are, in the various divisions of the Westinghouse organization, this summer, about two hundred juniors. We are making a study of the problem of absorbing these men into industry for the summer months. We shall be interested in finding how many of them return, how effective their work is, and how much of a jolt it puts on the departments to release them all at practically the same time. We trust that you men who will come in contact with these under graduates, after their return to college, will investigate the matter from your viewpoint to find out what they have gotten out of their summer's work and how you can use their experience in connection with your teaching program. Within another year we should get together and discuss this matter on a basis of actual facts.

There are undoubtedly a number of students who drop out of the university after the second or third year. Could we not in industry coöperate with the universities in aiding worthy students who have had to drop out, because of financial reasons, to continue their school work in the evening while working during the day. Several hundred of the young men in our organization are planning to secure their degree by this method.

Another line of coöperation is through the alumni. Are the technical schools using their alumni to the very best advantage as a means of forming closer connection between themselves and industry? Local alumni associations can be formed in industrial centers—we have a number of them down in Pittsburgh. Why could not a little time be spent at alumni reunions in securing closer contact with the alumni who are in industry? Those who have been out five or ten years should all have different slants on the problem and should be in a position to contribute something worth while to their alma mater.

In the night school which is conducted in conjunction with our works we have taken up with the alumni the matter of furnishing the school with a number of practical problems for class room work. The result has been very much worth while. It has increased the interest of the alumni in the work of the school and has given the students a series of problems which are up-to-date and real.

Industry can coöperate with the schools in supplying them with lecturers, lantern slides and moving pictures covering various phases of industrial work.

Many of the industries make special rates to the schools for laboratory equipment, particularly when standard apparatus is used.

The engineering societies can be used as a means of securing closer contact between industry and the schools.

Scholarships can be offered by industry to enable a number of their employees, each year, who should have the advantage of a college education, to secure it. Our company is now offering four industrial scholarships, each year, each paying $500 per year for four years. Either employees or the sons of employees may compete for these scholarships.

Possibly one of the best channels for coöperation between the technical schools and industry is, through the teachers. The instructor should be thoroughly acquainted with the work for which his students are being trained before he can hope to secure the best results. The industries should coöperate with teachers in keeping them supplied with literature and information about their product.

During these times the technical schools as well as industry are facing a number of very serious problems. The period is coming shortly when you will have to reman your organization. What kind of training are you going to require for teachers. If some practical experience is considered advisable for technical graduates before taking up responsible positions in industry, why should the same requisit not exist for those who are to enter teaching? I am quite sure that our organization would be willing to coöperate with the technical schools in this connection. We can assist by offering our graduate student training to a number of graduates, each year, who are selected by the various schools to take up engineering teaching. A schedule could be worked out to give these men experience along certain lines according to the needs of the school. In case it was felt desirable to secure alumni from other institutions, as teachers, an exchange agreement could possibly be worked out between the various institutions using this service.

During the past ten years our organization has conducted annual summer conferences for teachers. Approximately 175 professors and deans have spent five weeks in our plant studying methods of manufacture and organization and getting acquainted with the engineers who are responsible for progress in various lines.

In conclusion I might mention several matters which seem to me to have a bearing on the problems of engineering teaching.

A recent report published by the educational committee of the British Electrical and Allied Manufacturers Association, urges the schools of England to keep their engineering education as broad and fundamental as possible and recommends that either two or three years of practical training, in industry, should furnish the basis for an engineering career.

It is my personal conviction that instruction in economics and English should be considered as a part of every subject taught in the engineering curriculum. If a student is studying transformers, let him write up his reports in good English and according to the best engineering practice and let him understand while learning the theory of the transformer, why it has a place in our engineering practice and the various economic problems involved in its design, construction and application.

The knowledge of human nature is now more necessary for success in engineering than it has been heretofore. If your graduates are to fill the place in the world which you have in mind for them, they must know how to deal with people and they should have secured some theory and practice in this connection before entering industry.

Many of our engineering students lack what we might call a business sense; knowledge of those principles which enter into good business practice and an ability to apply them.

It might prove of interest to those responsible for carrying on technical training to investigate the motives which lead men to take up a college course. I have met a few men during the past year whose motive in going to college must have been to get out of work.

In looking over the diploma, some time ago, which I received when I graduated, I find that it states that in view of having received my training I am now to be accorded "Rights, Privileges and Honors." After a number of years in industry it is my conviction that my diploma should have said "You are now ready to go out for a full life of hard work and to pay back to society a portion, at least, of what society has done for you."

COÖPERATION BETWEEN ENGINEERING SCHOOLS AND THE UTILITIES.

BY H. B. SHAW,

Henry L. Doherty & Company.

In discussing this subject, it may be taken for granted that effective coöperation can be secured only by complete mutual understanding as to matters of mutual interest, for mutuality of interest is the starting point for coöperation and the necessary teamwork develops only through the understanding which comes to those who work together to a common end. There is very little coöperation between engineering schools and utilities, and that little not organized, and it would seem to be easy to secure more effective results by formulations of plans for coöperation, which would provide for more intimate understanding on the part of those coöperating, and assignment of the work so that each individual participating may understand the plans and be enabled to fit his work to it. Coöperation within organizations has come to mean so much that coöperation with others naturally appeals to utilities, and besides there is already a large measure of coöperation between different utilities as in the utility associations. So a pertinent suggestion is for the Society for the Promotion of Engineering Education to take the initiative in asking for coöperation with say the National Electric Light Association and other similar national and state associations. The cooperation of such national societies as the A. I. E. E. and A. S. M. E., etc., in establishing student branches, educational committees, etc., has already proved of value to engineering education, and carried further along the line proposed by President Hollis at yesterday's meeting will doubtless be extremely valuable, and possibly epoch making. Why should not coöperation with utilities, by which so large a proportion of engineering graduates are employed, be beneficial to the engineering schools and enable them to more adequately educate their students?

It is generally believed that there is too much of a gap between the engineering school and the practice of engineering and possibly more of a gap between the school and engaging in business, such a gap does not however appear between the practice of engineering and business, in fact most engineering graduates find that they are engaged in business of an engineering character rather than putting into practice the engineering learned in college. By starting coöperative courses, some engineering schools have narrowed the gap and the great increase in summer vacation work for undergraduates is tending in the same direction and proving generally adaptable. Coöperation may bridge or even eliminate the "gap" and bring the schools and the utilities closer together.

In years past many a business has been improved or even rescued by the introduction of engineering principles, but nowadays there does not seem to be much difference between the underlying principles of business and engineering. Both require that real service be rendered, in which they do not differ from engineering schools; in both, the returns must be adequate in order to secure their continuance and the maintenance of the service; in both, team work and organization morale are essential to the success of large undertakings. These highest interests of both business and engineering are in harmony with and not opposed to the best interests of communities and individuals.

The outstanding interest in common between engineering schools and utilities or other businesses appears to lie in the employment of engineering graduates; for teachers, the graduates and business men alike are interested in the graduates having full opportunity to develop through experience under responsibility with selection which provides "the right men in the right places.'' One of the greatest satisfactions in life must come to teachers in knowing the success of their students and realizing that they have contributed to that success through their counsel, guidance, and instruction, as well as by their personality and example. Teachers of engineering especially have a right to pride of workmanship in the service they perform in preparing young men for engineering, industry and business.

The firm with which I am connected, Henry L. Doherty & Company, has taken the greatest interest in the selection and training of young men in its utilities and oil businesses, and has had fourteen years of experience under a plan of employing engineering graduates and giving them, individually, a diversified and comprehensive training in the different phases of the businesses. Through this training these graduates have developed in the organization into positions of responsibility in financial and business lines as well as in operating and engineering.

Few of the engineering graduates we have employed have been educated in gas or petroleum engineering. Many of them have not had these businesses called to their attention, nor have they in general acquired the fundamentals peculiar to and underlying them. In fact, these great fields of business and engineering endeavor, one relatively old, the other somewhat new, are as near as we can ascertain hardly ever referred to in engineering courses, unless it be in chemical engineering, mining engineering, or in geology, the latter of which, unfortunately, many engineering students do not study. Engineering students are taught the production and use of manufactured products and the production, distribution and use of power and of electricity. So, it seems strange that in general they are taught practically nothing about the production, distribution, and utilization of artificial and natural gas, or of petroleum, and for that matter too little about heat, fuel and combustion in their industrial aspects. The field for the economic utilization of heat is relatively enormous and even surprising to those who have not been in touch with it, and the gas business is comparable with the electric central station business when measured by investment, volume of business, or service rendered.

It is true that the gas business has been held back by using unscientific and unprofitable forms of rates, by the requirements of candlepower and other standards and by the crediting of the proceeds from sales of by-products to the cost of manufacturing gas, thus preventing the most economic utilization of fuel and forcing waste.

Recently we have attempted to crystallize our experience in training and put it in the form of specifications for engineering graduates, which were prepared in connection with a coöperative plan initiated by Dr. Hollis Godfrey, under the auspices of the Technology Clubs, Associated. The attitude of business men and of the industries toward coöperation has been shown by their support of this coöperative plan. These specifications together with others are being analyzed from the educational viewpoint, and are to be published later with analyses and discussions.

Henry L. Doherty & Company's Specifications for Technical Graduates.

These specifications are a part of a coöperative plan which has been undertaken to arrive at a more complete understanding between the industries and technical schools, and to aid in improving the product of the schools, the judicious selection of graduates, and the work of the graduates in the industries. They are intended to cover the number and qualifications of graduates to be selected for employment by Henry L. Doherty & Company. They are based upon the experience gained in employing and training a considerable number of graduates during the past fourteen years. They are admittedly incomplete as the attempt has been made to point out the particulars in which it is believed graduates considered as products of the colleges may be improved and better fitted to start their work in industry.

The graduates employed by Henry L. Doherty & Company will be expected to develop through training and experience into positions of responsibility and usefulness in the different parts of the business which consists of supplying electric, gas, water and heat service, street and interurban transportation, and of the production, transportation, refining and distribution of petroleum and its products.

Graduates are desired who when trained can:

1. Help protect investments by proper construction and operation, by courteous and straight-forward dealing with investors, customers, the public, state and municipal authorities, regulatory bodies and fellow employees.
2. Aid in the development and extension of the market through rendering the best of service and through the most economic utilization of resources.
3. Help solve our problems, technical and human, capably meeting situations as they develop.

From one hundred to two hundred graduates a year will be employed, as they may be selected through recommendations of teachers, visits of representatives to colleges and interviews with applicants. It is desired that the selection be mutual, each applicant understanding as clearly as possible the training and the work which he will afterwards be expected to do and the organization's representative believing that the applicant will be especially suited to the training and to develop into a useful and effective member of the organization.

It has been found by experience that the qualifications necessary for success in engineering work and operation in the utilities and oil businesses, the lack of any one of which is liable to retard the graduate's advancement are as follows:

1. Graduates in engineering are desired for they will have to deal with operations primarily dependent upon natural laws, and it should be clearly recognized that the men selected are expected to develop in the utilities and oil businesses rather than merely put into practice what has been learned in college.
2. These graduates should be educated in the fundamentals of physics, chemistry, economics, psychology and engineering, and have the ability to use these fundamentals without conscious effort to meet methods, processes, conditions and situations. They will have to deal with materials, money and men and will have continuous and progressive need for these fundamentals in all of their work. It is considered unwise for a graduate to have specialized at the expense of a thorough grasp of any fundamentals, for too early specialization has the tendency to narrow one's vision and to restrict his field

of future usefulness. Specialization will most naturally come with experience, for many graduates now find themselves specialized beyond the point which they may possibly attain in some years of work. For example, one graduate in a thousand may find his opportunity in specialized design of some kind, whereas nearly everyone needs to know values and costs, and the laws of supply and demand.

3. The graduates should be men who finish what they start, who get what they go after, not easily discouraged by bad luck or by criticism, but who will put forth every effort to succeed. The man who fails to complete the work he has undertaken not only renders no service but actually delays the progress of the work and makes it necessary for someone else to begin it over again and carry it through to completion. Only such graduates as stay with the organization and develop effectively compensate it for the training provided.

4. The graduates should be men who will develop tact and diplomacy, who will meet the public fairly and openly and create friendly relations. Besides dealing with machinery and natural laws these men will also have to deal with men and affairs, meeting, pleasing and convincing fellow employes, customers, investors, the public, city and state authorities and regulatory bodies. They will be expected to develop initiative and coöperation as engineers, leaders and executives in the organization, being not "star players" but team workers.

5. The graduates should be men who have been trained to think for themselves, of conservative judgment, but not bound by precedents, who can be trusted to try out new and untried methods; men who think straight and through to conclusions, who, having will for action, act promptly, effiectively and justly; men who quickly familiarize themselves with all the vital factors of a situation and then form sound judgments, and who have ability to express those judgments so as to convince and stimulate others.

We insist that judgment is the foundation of engineering because no amount of mathematical or other knowledge can eliminate judgment, as for instance in the selection of the most economic process, the proper factors of safety and stability, the return to attract investment, the funds to be set aside to protect a property, or the permissible operating labor costs, etc.

It is realized that sound judgment of men and matters does not usually come at an early age, and is probably developed most fully through considerable experience under responsibility. Yet it is firmly believed that graduates should come to us convinced that technical training is not a substitute for good judgment but a very valuable assistance thereto, and should have made at least a start toward developing in the exercise and expression of judgment, which is considered the most important qualification for successful service. The effect which engineering education has in developing thinking and judgment is recognized, but men are desired who have had more training in thinking as contrasted with learning the thoughts of others and more systematic training in the exercise and expression of judgment. As a suggestion and not as an attempt to specify the educational process as well as the product, it is believed that the substitution of the exercise and expression of judgment on matters familiar to the student and germane to the study might well be substituted for examinations.

6. The graduates should be adaptable to honest business and commercial practice. They should at least realize that the operation of a utility such as a central electric station is a business enterprise, and not merely the application of physical laws pertaining to combustion, steam and electricity, and further, that safe, adequate and reliable service must be furnished and sold at a profit.

7. Graduates are desired who have sound constitutions and general good health; not necessarily large but able-bodied and active. The value of good health and sanitary habits in production and service can hardly be overstated as every individual realizes the effect of good health and good habits on himself and on his work.

8. Each graduate should be a man who will function properly in the organization in which he works, with, through, and for others and where the emphasis is placed on accomplishment and service rather than on the acquirement or possession of knowledge. It should be realized that initiative is most desirable but it must be tempered by the spirit of coöperation, and that pride of workmanship, pride of service and habits of thrift are essential to organization teamwork.

These specifications are the result of our attempt to incorporate in that form the characteristics and qualifications which we believe make for success in the utilities business—success as measured by service as well as by its reward. It is evident that they specify qualities desired rather than knowledge acquired.

It is requested that the exact wording of the second qualification should be noted, viz. "the fundamentals of physics, chemistry, economics, psychology and engineering" as care was taken not to refer to "fundamental subjects."

Also, the attempt has been made to emphasize fundamentals and to ascribe as great relative importance to the fundamentals of economics and psychology as to those of physics and chemistry.

The idea is somewhat generally prevalent that mathematics is the basis of engineering, but while it is realized that mathematics is a necessary prerequisite to a number of studies in engineering curricula, yet the great majority of practicing engineers can hardly be said to do their thinking by precise mathematical methods. Engineering practice is largely economic and social, and requires leaders who have sympathetic understanding of human nature and of economic and social relations, because they have to deal not only with materials, machinery and the natural laws, but mainly with men, money and methods.

It is assumed that engineering educators are agreed generally that it is necessary for engineering as well as other students to develop first of all as *men and citizens,* so that through their engineering work they may serve and advance to the limits of their capacities, that is,

(1) That they may live and act aright.
(2) That they may think straight and through to conclusions.
(3) That they may be of the greatest service in engineering practice and in business.
(4) That they may develop unfaltering confidence, imagination, will for action, constructive initiative, and unhesitating coöperation.
(5) That, above all, they develop steadily in the exercise and expression of sound judgment so as to convince and stimulate others.

It is highly desirable that the education offered should be such as to develop character and *personal power* and should provide a thorough grounding in fundamentals, not specializing, but "broadening." Specialization comes early enough after some experience. This does not mean that they should not learn about the kinds of work they may be called upon to do as engineers. It is suggested that there should be conscious effort to develop character and personal power even to the extent of eliminating some of the technique.

The most promising effort would naturally be to plan to have students join in the exercise of *judgment,* in *thinking,* and in *expression,* and submitting specifications such as the foregoing to engineering students for their critical analysis, judgment and expression of opinion might prove most interesting. Might we not consider the development in *thinking,* in *judgment,* and in *expression* as the essentials in engineering education.

It is suggested that curricula should not be planned to fit the then teachers, but rather with the view of providing what the majority of students and also the best of them should learn in order to make themselves of the most service. The work having been planned, teachers should be selected who can best carry out the plans and have assigned to them the teaching for which they are best suited.

Engineering teachers might well have more engineering and business experience and the younger men without much experience in life or in engineering should "carry on" under the guidance of leaders who are experienced.

It should be recognized that students have different abilities, capacities and *aptitudes;* some are most interested in and early acquire languages, some are mathematically inclined, some take naturally to the natural sciences and engineering, some are interested in construction and in machinery; too few are inclined to study men and human nature, and so to develop early as leaders. Individual students generally show most interest in one or the other of the interests mentioned, but rarely indeed in all of them.

So it may be suggested that the first step in "balancing an engineering curriculum" is to decide upon the irreducible minimum for all students in engineering, which for lack of a better name may be called "Prerequisites" and "Engineering," and then to use the rest of the curriculum to develop the "aptitudes" of each, by more intense and further study of fundamentals.

By the way of illustration, assume the curriculum is to contain 40 studies in a four year course in general engineering.

The "Prerequisites" might be 20 of the studies.
The "Engineering" might be 10 of the studies.
The "Aptitudes" might be 10 of the studies.

divided perhaps as follows:

Prerequisites:

English	2	studies	
Mathematics	2	"	
Chemistry	2	"	
Physics	2	"	
Economics	2	"	
Psychology	2	"	
Geology	2	"	
Production methods	2	"	(modification of "shopwork" and drawing.)
Mechanics and construction	2	"	
Engineering principles and applications	2	"	
	20	"	

Required Engineering:

from Civil Engineering	2 studies
from Electrical Engineering	2 studies
from Mechanical Engineering	2 studies
from Chemical Engineering	2 studies
from Industrial Engineering	2 studies
	10 studies

Electives—"Aptitudes":

Cultural—Minimum	2 studies.	Maximum 4 studies
Scientific—Minimum	2 studies.	Maximum 4 studies
Engineering—Minimum	2 studies.	Maximum 4 studies

Total of 10 studies.

Naturally each study would have to be coördinated with the others.

The curriculum is confined to "fundamentals."

Specialization and too intense study of current practice are avoided.

It is suggested that economics and psychology are as much needed for the future work of graduates as physics and chemistry.

The mere naming of the studies in a curriculum gives very little idea of what is taught, and it seems necessary to go into the content of studies and the teaching for the personality and force of the teacher may make alive the dry bones of almost any study.

It is suggested that chemistry and economics should be welded into engineering studies as physics has been, and this would also apply for such subjects as geology, metallurgy, English, economics, etc.

The initiative and coöperation of engineering teachers seems to have been hampered by too clearly drawn lines between "fields of knowledge." Does the dean or professor visit the classes or another teacher? Does any one teacher have a clear conception of what is being taught by his colleagues or how it is being done?

A thorough study of the work of students after graduation, especially as to what studies and development will best fit them to be of service, to think straight, to live, should prove of the greatest value in suiting the education to the many and giving greater opportunities to the few who have proved and they will benefit by it.

A most promising way of coöperating was started recently by Dean Sackett of Pennsylvania State College, who invited representatives of several concerns, which employ engineering graduates in considerable numbers, to an "across-the-table" conference on education for future usefulness. The interest of the utilities and industry generally in such coöperation was evidenced by the alacrity with which they accepted and participated in the heart-to-heart discussions, and the writer for one will appreciate being included in any further conferences of this kind.

Among other matters in which coöperation should prove of value, a study of the work engineering graduates do after graduation is suggested. Each engineering school would itself benefit by undertaking such a study of the work of its own graduates and the Society for the Promotion of Engineering Education could properly undertake the correlation of the separate studies and obtain or aid in obtaining the coöperation of men in industry.

As engineering graduates find work in many localities and in diverse employment and as conditions are continually changing, the studies should be continuous and made under a general plan for the gathering of data, making analyses, and distribution of the results.

With such information and results available, it would be possible to plan with foresight for the education of young men in engineering.

As an illustration of one phase of study of the work of engineering graduates, alumni directories of three engineering schools were obtained about a year ago, which gave sufficient information to make the following classification of their graduates according to their employment.

The statistics for three schools only naturally do not give a general representation for all engineering schools, but they do give a definite impression that a relative large number of engineering graduates are employed in industry and with business concerns and that relatively few are engaged in engineering work in an individual capacity. We should not reason from this that it is wrong to direct the education of engineering students toward the highest professional attainments, but on the other hand the future of the great majority of them depends upon the education being suited to their needs, their capacity, and their future work. Herein lies the value of knowing the work students will be called upon to do, and a knowledge of utility work will enable teachers and students to plan and develop with foresight and confidence.

Each engineering school could without extraordinary effort classify its graduates by employment, and in so doing get the

Classification of Employment of the Graduates of Engineering School—A.

Compiled from Bulletin of 1917–1918.

	No. of Graduates in Each Class.	Percentage of Total.
With operating organization (public utilities)...	377	19.35
With operating organizations (not public utilities)	309	15.86
With manufacturing organizations	269	13.81
With constructing and contracting organizations..	116	5.95
Total with organizations	1,071	54.97
Teachers	102	5.24
In municipal service	91	4.67
In government service (army and navy)........	294	15.09
Total in public service (government).......	484	25.00
In operation, individual	49	2.52
Individual contractors	18	0.92
Individual consulting engineers	17	0.87
Technical experts	21	1.09
Total individual	105	5.40
Not in above classes	285	14.64
TOTAL	1,948	100.00

Classification of Employment of the Graduates of Engineering School—B.

Compiled from Alumni Directory of 1918.

	No. of Graduates in Each Class.	Percentage of Total.
With operating organizations (public utilities) ..	151	17.98
With operating organizations (not public utilities).	178	21.22
With manufacturing organizations	186	22.18
With constructing and contracting organizations ..	36	4.29
Total with organizations	551	65.67
Teachers	33	3.93
In municipal service	17	2.02
In government service (army and navy)	144	17.16
Total in public service (government)	194	23.12
In operations, individual	10	1.19
Individual contractors	5	.6
Individual consulting engineers	12	1.43
Technical experts	8	.95
Total individual	35	4.17
Not in above classes	59	7.04
TOTAL	839	100.00

CLASSIFICATION OF EMPLOYMENT OF THE GRADUATES OF ENGINEERING SCHOOL—C.

Compiled from Bulletin of June, 1918.

	No. of Graduates in Each Class	Percentage of Total.
With operating organizations (public utilities)....	132	16.73
With operating organizations (not public utilities).	213	27.00
With manufacturing organizations	55	6.98
With constructing and contracting organizations..	17	2.15
Total with organizations	417	52.86
Teachers	30	3.80
In municipal service	24	3.04
In government service (army and navy)	138	17.49
Total in public service (government)........	172	24.33
In operations, individual	15	1.90
Individual contractors	5	0.63
Individual consulting engineers	13	1.65
Technical experts	7	0.88
Total individual	40	5.06
Not in above classes	140	17.75
TOTAL	789	100.00

benefit of the study through having attention focused on the work of the graduate, and when the individual statistics are compiled and analyzed, be in a position to make valuable comparisons and deductions. It is assumed that engineering teachers generally know about engineering work which is going on and about business usually at secondhand, and usually do not have the benefit of the development that comes through the actual doing of engineering work; and it is believed that no one really knows quite so well had to do anything as the one who has just done it well.

Business requires continuous and at times daily marshalling of facts, relations, and motives, a constant study of situations and, besides, prevision and even definite action considerably in advance of the march of events. Thus conditions not theories confront the business man, and the engineer.

Utilities and businesses generally are founded on sound economic and social ideas and ideals on which, in a large measure, their growth and success depends. Many of these ideas and ideals are hardly known outside of the organization though they may have been published. To illustrate may I not draw on the experience of the Doherty Organization which has benefitted so much by the ideas of Mr. Doherty. For example, he originated and developed the only really equitable and satisfactory idea for charging of utility service—the "three-part" or "Doherty Rate," which consists of a customer charge, a demand charge, and a quantity charge. With considerable reason it has been claimed that the fundamental idea in this rate, which has been largely introduced into electricity supply service, has proved the salvation of the central electric station business, and it is now looked to as a most potent factor in saving the gas business which is in eminent danger owing to the increasing of operating cost out of all proportion to income. Though the Doherty Rate was published twenty years ago it has not been generally introduced in the gas business, but now the necessity for it is being realized.

Recently the three-part rate for *natural* gas has been introduced in Ottawa, Kansas, using a demand limiting meter with so much success that it promises to be the solution of the natural gas problem because, to quote from a paper by Mr. Doherty "Service and Conservation Under the Three-Part Rate" for the Fifteenth Annual Meeting of the Natural Gas Association of America:

> "The Three-Part Rate by its very nature accomplishes the following:
>
> "First. Guarantees the customer that amount of gas for which he contracts, for every hour in the year, and makes it possible for the company to fulfill that guarantee.
>
> "Second. Conserves large amounts of gas by financially interesting each customer in adjusting his appliances to efficiently utilize gas.
>
> "Third. Conserves large amounts of gas by reducing the maximum demands of the customer so as to permit the company to supply these demands with much lower pressures in the distribution mains, thereby reducing the present leakage.
>
> "Fourth. It not only distributes the total cost of gas service to the customers as a group, but makes an equitable distribution of this cost as between individual customers.

"Fifth. By conserving the present supply, and by making the same service possible with a smaller supply of gas, postpones the date when service must be curtailed due to the decline in the fields.

"Sixth. Makes possible a pro-rata curtailment of service to all of the present customers instead of making it necessary to entirely discontinue the service to some customers when curtailment becomes necessary.

"Seventh. Does away with the present discrimination on cold mornings whereby those customers nearest the supply lines use wasteful amounts while other customers do without any gas.

Eighth. Permits the company to know for months in advance the maximum amount of gas it can be called upon to supply in any peak hour.

"Ninth. Puts a premium on the manufacture and use of efficient devices and holds out a prize for the invention of devices using small or maximum demands.

"Tenth. Makes a better credit risk of any company which adopts it in place of a straight meter rate."

To conclude, it is believed that the coöperation between engineering schools and the utilities should prove extremely valuable to both.

Each would benefit by learning more about the other.

The utilities would secure a better selection of engineering graduates better suited to their work.

The engineering schools would be enabled to keep better in touch with the work of utilities; its progress and its trend.

The engineering schools could probably arrange for utilities information service, say from the National Electric Light Association, which would be up to date and through a study of which engineering graduates would know about the work before they undertook it.

Engineering educators would be able to plan and carry out educational programs with foreknowledge of the effect on the work of students following graduation.

Joint specifications for engineering graduates could be perfected outlining clearly what qualities and knowledge graduates need, and also how they should be educated.

"Liaison" officers might be necessary to coördinate the work developed under coöperation, and it may not be amiss to suggest such officers for coördinating the work within the engineering schools.

Engineering schools might establish personnel officers or personnel departments, similar to those common in the industries, whose main duties would be to develop character and personality of students, thus insuring that the engineers of the future will be most effective *men.*

DISCUSSION.

A. H. Fuller: In his interesting paper on coöperation, Mr. Coler has acknowledged a responsibility on the part of the industries to tell the colleges what kind of men are needed in the industries. Dean Shaw has followed this with a carefully worded and altogether excellent specification which the colleges may or may not be able to fill within the limitations of time and material at their command.

Mr. Coler follows his statement with the suggestion that the colleges make more exacting specifications for high school preparation than is now being made.

I wonder if he does not lose sight of the fact that we, as college men, recognize that college domination of high school work has already gone too far. Wouldn't the spirit of coöperation be more effectively carried out if the industries would furnish, along with the specifications, rather definite information concerning the performance of the college men in their employ. Then why not use this information and the specifications as a basis for getting together in a true spirit of coöperation.

H. B. Shaw: One of my suggestions was that each engineering school should, with the aid of its alumni, study the work of its graduates, and as an illustration, classification of engineering graduates by employment was given.

Those who employ engineering graduates will no doubt be glad to coöperate in the way suggested by Dean Fuller, if they are informed as to how they can furnish "rather definite information concerning the performances of the college man in other employ."

Henry L. Doherty & Company's specifications for technical graduates are directed particularly at those " performances " which were detrimental to the graduates in our employ and retarded their advancement. These specifications attempted to outline qualities and characteristics of graduates which would prove most valuable, and they resulted almost entirely from observing qualities which engineering graduates coming under our observation, generally lack.

Employees find it peculiarly difficult to form judgments of engineering graduates in the early years of employment for it usually takes considerable time for the graduate to find himself, to get the requisite knowledge of the business, and then to specialize in that phase of the business for which he is best adapted. In many cases graduates with us have failed to perform acceptably in several assignments before they were assigned to work in which they proved themselves valuable.

I really believe the study of the work of graduates with the industries should be undertaken by the engineering schools and that the engineering schools should accordingly have the coöperation of their alumni in making such studies and they can easily secure the coöperation of such concerns as regularly employ engineering graduates.

INTERDEPARTMENTAL COÖRDINATION.

BY GARDNER C. ANTHONY,

Dean, Engineering School, Tufts College.

When we shall come to understand the true function of education and properly relate the teaching of engineering facts to the development of men, we shall realize the present inadequacy of independent departmental instruction which is largely an inheritance from the academic colleges.

The demand which is now being made on the engineering schools by the commercial and engineering world is most significant in that little or no stress is laid on training along special lines, the question of departmental training being quite generally ignored in the selection of men.

If these statements are true, even in part, we cannot greatly improve our work as educators by greater refinement in the development of specialties, technique, or laboratory apparatus, but must strive to unite our faculties for the better coordination of our courses and a more systematic study of the individual characteristics of our students.

I believe that no engineering faculty or individual would acknowledge a disbelief in, or failure to encourage greater coördination between departments, but I suspect that many of our ideas as to the ways and means of accomplishing the desired ends are crude, and we must admit that in general, progress has been ridiculously slow.

The correlation of closely related courses such as mathematics and mechanics are presumably quite common, and in coöperative schools the work of the coördinator is accomplishing much to weld the several units of a technical school, but the spirit of this has not entered largely into the work of the individual who is usually much more interested in the teaching of his subject than in the mental and character training of his pupil. We all are more or less guilty of magnifying the means rather than the ends of our labor.

The importance of this subject has been brought to my notice most emphatically in the working out of the new curriculum at Tufts, by reason of the composite character of the courses. The curriculum has necessitated a better understanding of the work of the individual instructors whose instruction is so closely related, and has served as a check to the tendency of subdividing subject matter which in recent years has belittled the importance of fundamentals.

Even the phraseology of instructors in related courses may be a not uncommon cause of delay in the progress of students. an excellent illustration of which came to my notice a few days ago on the occasion of a conference between departments for determining the character of a new course in physics for junior engineers.

The professor of physics was speaking of the difficulty which he had experienced in getting students who were able to plot y sin x curves to also plot sine curves of different period, phase and amplitude, and he remarked that they seemed not to have heard of such a thing. The professor of mathematics replied: "If you had used the term 'modified graphs,' the students would have recalled being taught to do the very thing which you desired to have done," and, he added, "I wish that men of the faculty knew what we were teaching or else give us their version of equivalent things." This, in itself, was a small matter but very significant as regards the importance of coöperative work.

Until one has made a practice of coöperating with the several departments which afford any points of contact with his own, and persuaded them to create more points of contact, he fails to realize the opportunities for broadening his own.

The work of a coördinator may cure some of these evils and effect a greater solidarity of departments, but the real work must be done by creating more of an individual interest on the part of members of the faculty in the work of their associates in other departments. The practice of visiting classes, not for a single recitation, but for a considerable number, is most beneficial, and while I realize the difficulties due to program interferences and excessive programs, is that not a question of administration which demands immediate attention.

This suggests too the division of responsibility between the heads of departments and within the departments themselves. To what extent do you the heads of departments assume the responsibility for the training of teachers, especially those who have been called from the practice of engineering to teach for the first time? Do you know the value of subordinates as teachers irrespective of their knowledge of the subject taught? Do you supervise the examinations given in the several courses which serve, in a greater degree as a test for the teacher than for the pupil?

I firmly believe that comparatively little has been done toward accomplishing the above ends and for two very good reasons. First, because of heavy programs which are frequently accompanied by outside engineering practice; second, because of the undue stress laid on the subject taught.

Perhaps the work of supreme importance—and difficult of realization because it requires the most expert judgment—is to correctly diagnose the mental difficulties and bad intellectual habits on the part of students. The highest qualification possessed by any teacher is the ability to accomplish this end and beside which the lecture, recitation, and laboratory as means for dispensing technical information is of secondary importance. In this, more than in all else, we need to know the experience and methods of our associates and coöperate with them in the discussion of student cases and character studies.

I realize that these statements are generalizations and the criticism not of a constructive character, but it is my intention to do little more at this time than to sound the note of interdepartmental coördination and coöperation in the hope that something constructive may arise from sympathetic consideration.

AN EXPERIMENT IN THE TEACHING OF CALCULUS.

BY E. F. CODDINGTON,

Professor of Mechanics, The Ohio State University.

The writer has for some time entertained the idea that the mathematics taught during the first two years of our engineering curricula, especially the calculus, means very little to the engineering student. The main reason for this fact is the inability of the average student to comprehend the mathematical conceptions as they are ordinarily presented to him. Too often all the student succeeds in learning is how to perform the mechanical manipulation of the operation involved, without gaining any comprehension whatever of its meaning. Then, when he attempts to apply this fundamental mathematics to his special technical work, he is more or less helpless and bewildered and consequently does not succeed with it. The effect of this procedure is cumulative during the four or more years of an engineering curriculum. In the first place, the student soon acquires the idea that he can not understand any of his work and soon gives up trying; he becomes satisfied with carrying out mechanically the details of the work assigned by the instructor, without any attempt to analyze and obtain a mental grasp of the subject with which he is dealing. This does not inspire the student with the proper interest and enthusiasm towards his work; it tends to make him slipshod and careless in habit. The results are just the opposite in every respect from what they are intended to be.

In order to determine how much truth there is in the above analysis of the situation the author tried, during the past year, in teaching calculus to a class of sophomore engineers. I believe I have obtained some encouraging results:

THE INTRODUCTION TO CALCULUS.

The introduction was quite informal and unconventional. At the first meeting of the class the following problem was discussed:

A square whose side is 10 inches in length was given and the class was asked to compute the increase of area as each side is increased to 11 inches in length; also the ratio of the increase of area to the increase in length of the side. The same operation was repeated for an increase in length of 0.1 inch, .01 inch and .001 inch. It was soon apparent to the class that this ratio approached the number 20 as the increase in length of the sides approached zero. Attention was then directed to the fact that what had been computed was the rate of increase of the area of the square with respect to the rate of increase in length of the side of the square. In order to show that this rate of increase depends upon the length of the side a larger square was taken and the same operations repeated.

The problem was next generalized by letting x be the length of the side, Δx the increase in length of the side, A the area and ΔA the increase of the area. The class experienced no difficulty in deriving the equation

$$\frac{\Delta A}{\Delta x} = 2x + \Delta x,$$

which becomes, when Δx approaches zero as a limit

$$\frac{dA}{dx} = 2x.$$

The significance of this equation should be illustrated by citing examples of squares growing by receiving additions on two sides at a constant rate.

A city whose boundary is a square each side of which has the length x ft., has a strip of land 50 ft. wide added to two sides of it each year; show that the rate of increase of area of the city varies directly as x.

The following problem was assigned to be solved and handed in at the second recitation. Given a circle with radius "r" and area *A;* to derive and interpret the expression for dA/dr.

The members of the class discovered that r^2 in the second problem received the same treatment as x^2 in the first and that the sole difference between the two problems was that in the second problem π was carried through as a multiplier.

For the third day an equilateral triangle with length of side x and area A with $A = \sqrt{\tfrac{3}{4}}x^2$ was assigned and the class was directed to derive dA/dx by the rule discovered from the previous problems and to show that from geometry

$$\sqrt{3/2} \times \Delta x$$

is the principal term in the expression for ΔA.

The number of such problems in area can be extended indefinitely by taking the regular polygons.

In this way, the rule for differentiating a variable raised to the second power was derived and the meaning of differentiation was illustrated.

On the following days, volumes of cubes and spheres were used to derive the rule for differentiating the third power of a variable and again to illustrate the meaning of differentiation.

No attempt was made to define functions, variables, limits, etc., until these terms had been illustrated by the simple geometrical problems already mentioned. As soon as the students had been made familiar with dependent and independent variables by these examples, the derivative was defined as the rate of increase of the value of the dependent variable with respect to that of the independent variable.

No attempt was made at any given recitation to drive this definition home, but its meaning was emphasized and amplified by a discussion of an assigned illustrative problem at each meeting of the class. As soon as problems involving decreasing functions were taken up, attention was directed to the fact that the derivative is positive for values of the independent variable for which the function is increasing and is negative when the function is decreasing. At this point the conditions for maximum and minimum values of a function were discussed.

The main effort on the part of the instructor during the first half of the semester was intended to make clear the meaning of the few new terms which are generally discussed in the first chapters of the textbooks on calculus. No attempt was made at rigorous demonstration, but every attempt was made to have the student gradually acquire a comprehension of the meaning of the operation of differentiation.

In order to accomplish the end just described methods were introduced which I do not believe are commonly used. These methods are as follows:

1. The use of an illustrative problem at each recitation.
2. A correlation between the calculus and physics, the two subjects being pursued concurrently.
3. The requirement that all assigned problems be solved on standard size paper and handed in to be graded.
4. The distribution of the assignment for each day over as many topics as problems assigned.

ILLUSTRATIVE PROBLEMS.

Allusion has already been made of the use of illustrative problems to make clear the meaning of differentiation. I started the year's work with the idea of assigning one such problem for each recitation. Simple geometric problems involving areas and volumes were used in the beginning. By the time the students could handle these subjects with some facility the subject of motion had been taken up by them in physics. After the first two or three weeks no difficulty was experienced in finding practical problems in the textbook—Osborne's—to use as illustrations.

At each recitation the illustrative problem was analyzed and the meaning and significance of the derivative in its solution was brought out. Take, for example, the following problem of a body projected vertically upwards with an initial velocity of 100 ft. per second. Neglecting the resistance of the air the equation of its position with respect to the time is

$$y = 100t - \frac{gt^2}{2}.$$

Differentiating we derive

$$\frac{dy}{dt} = 100 - gt.$$

Analyzing the derived equation, we find that y is an increasing quantity for values of t less than $100/g$, constant when t equals $100/g$, and decreasing when t is greater than $110/g$. Also, the magnitude of dy/dt for different values of t indicates the rate of increase or decrease of y with respect to t at the corresponding times.

Problems of this kind lead directly and naturally to problems of maximum and minimum values.

At each recitation members of the class were called upon to explain and discuss the problems assigned to be handed in at that time. The writer believes this daily assignment of an illustrative problem with the rather complete discussion of it in the class-room enabled the students to obtain a better comprehension of calculus. Since these problems required the differentiation of several kinds of functions, the students were easily convinced that it was worth while to learn to differentiate all types of functions in order to be able to handle the particular type involved in any given problem. The students were thus led to solve problems in formal differentiation with more interest and enthusiasm than is usually manifested by students of calculus. Furthermore, the significance and meaning of differentiation in these formal problems was also discussed and often but not always illustrated by diagram. I should state at this time that the slope definition of a derivative was kept in the back-ground in the beginning. This idea of the derivative came, however, very easily and naturally when applications involving it were taken up.

CORRELATION OF CALCULUS AND PHYSICS.

The correlation which was effected between these subjects was brought about by an exchange of visitations between Professor Alpheus W. Smith, of the department of physics, and the writer. Each of us had essentially the same group of students in our respective classes. During the first semester I visited his recitations two or three times each week and he in turn visited mine an equal number of times. This arrangement enabled each of us to know exactly what topics were being covered in the related subject from day to day, and just what progress had been made by the class in that subject at any given time.

I was able, consequently, quite early in the semester, to select problems from topics already covered in the physics to illustrate the calculus. As has already been mentioned, problems in motion involving velocities and accelerations were taken up in the calculus as soon as these topics had been studied in the physics. In this way the students were strengthened in both subjects. The schedule in calculus was so adjusted during the early part of the year that calculus methods could be used in the development of certain topics in physics. For example, the rule for differentiating the trigonometric functions were taken up early in order that the methods of calculus could be used in the treatment of simple harmonic motion.

Professor Smith says that the presentation of simple harmonic motion under the arrangement just described was a decided improvement over the treatment ordinarily used. I am confident that the members of the class have a better understanding of calculus, a keener appreciation of its significance as a tool in the solution of real practical engineering problems, and consequently a deeper interest in it as a result of the coöperation between Professor Smith and myself. This application of calculus to the solution of problems in physics, coming within the first month of the semester, was, therefore, quite a motivating factor in inspiring interest in and enthusiasm for both calculus and physics.

Though Professor Smith and I did not find it convenient to continue the exchange of visitations during the second semester. We did hold several conferences concerning the progress of the students. As a result of these conferences and the familiarity gained by the visits of the first semester, Professor Smith made a much larger use of calculus in his treatment of elementary electricity than he had in previous years. In fact, he did not hesitate to make free use of calculus with the class during the second semester, wherever it could be used. Members of the class reported back to me that the applications of calculus in their physics were quite simple in comparison to those taken up in the calculus recitations.

This testimony from members of the class raises the question as to the relative efficiency of motivation by the methods used by Professor Smith and me as compared with methods used in the Engineer School at Camp Humphreys and described by Dr. C. R. Mann. The objection to the latter method is that the fundamental sciences are taken up in a piecemeal fashion as they are needed to solve specific engineering problems. Since the applications of physics and calculus in the solution of these problems are likely to be quite simple, the students are not likely to acquire much facility in the use of these subjects outside of the particular type of problems. A much more complete and thorough mastery of these subjects is likely to be acquired when they are studied for their own sake, using simple problems drawn from the students' experience to excite interest in them.

ALL ASSIGNED WORK TO BE HANDED IN.

In the first place, it was assumed that in order for the student to make any real progress in calculus, he must consistently work at it from day to day throughout the entire year. To bring about this result I introduced the requirement of having the students work out and hand in four assigned problems each day. No additional work was required. At first, I experienced quite a little difficulty in persuading some of the students that it was to their interests to do the work assigned them. They had not been given such treatment during the first year and why should they be so persecuted during their second year. While some members of the class willingly did the work assigned to them, others stated that they could not find the time to do it. About the middle of the semester, in order to determine if I was making the assignments too heavy, I decided to have them record on their problem sheets, the time spent on the daily assignment. This requirement resulted in a decided increase in the amount of work handed in. It furnished also some interesting information concerning the amount of time spent daily by each student on his calculus.

The results for the first day of this requirement are rather interesting. Out of a class of fifty, eleven turned in no work and accordingly no recorded time spent on the assignment. One of these eleven presented an acceptable excuse for not having done anything on the assignment. The remaining thirty-nine turned in times ranging from 30 minutes to 180 minutes. Two students spent 30 minutes each on the lesson, one of whom turned in all the assignment correctly done; the other received a grade of four out of a possible ten on his 30 minutes of effort. One student spent 180 minutes and received a grade of seven. No other student spent more than 2 hours on this assignment. The average time spent by each member of the class was 68.8 minutes. The results would seem to show that the students had not been spending an excessive amount of time on the assignments. The following table is given to show the improvement in the work done after the students began to turn in their time.

	Average Time.	Average Grade.
Nov. 21	No time recorded	49 per cent.
Nov. 24	68.8 min.	62 " "
Dec. 8	75.1 min.	74 " "
Jan. 5	85.0 min.	69 " "

The average of 803 individual reports of the amount of time spent on each lesson, not counting those who turned in no work, was 96.7 minutes. The daily average time increased slightly as the end of the semester approached.

Since the average daily problem grade made quite a jump—from 49 per cent. to 62 per cent.—on the first day the amount of time spent on the lesson was required, it would seem that the average amount of time spent on the assignment before November 24 must have been considerably less than 68.8 minutes. These data show that many of my students were spending very little time on my assignments although they knew I was grading them on the work handed in. These facts would seem to indicate that those instructors who loosely assign more or less indefinite lessons without any check as to how much is accomplished or how much time is spent on the daily assignments probably do not command a very consistent effort on the part of their students. At the end of the year several of my students told me that my requirement, that they should hand in the complete assignment each day was the largest factor in the success of the year's work.

The grading of the problems each day enabled me to keep much closer to the progress of my students than I could have done had I depended upon individual recitations for my information. It enabled me also to make assignments consistent with their progress. If a difficulty was encountered I discovered it immediately and consequently lost no time in clearing it up in the minds of the students. Additional problems were assigned involving the difficulty until I was satisfied that all the students understood clearly the point in question.

During the first semester I had about fifty students in the class and the time required to grade the problems and record the grades amounted to from 30 minutes to 60 minutes daily.

The Distribution of the Daily Assignment.

The object of distributing the daily assignments over as many topics as problems assigned was two-fold. First, this procedure enabled me to keep the class on each topic long enough to present it leisurely and also to make certain that all the difficulties of the topic had been cleared up in the minds of students before leaving it. Each topic was discussed very briefly on the day when it was first assigned and the simplest problem possible was selected to be solved and handed in as an illustration. On the succeeding day this would be put on the board and explained by some member of the class. After all questions concerning the problem had been answered a problem slightly more complicated was assigned for the following day. I generally attempted to anticipate any unusual difficulties of any assigned problem and to offer suggestions that would enable the class to solve it. I also placed obstacles in the way of the students just as fast as they showed their ability to master them. This procedure was made possible by my grading the assignment each day.

The number of recitations given to each topic depended upon the difficulties involved. No topic received less than ten recitations; to some of them a month was devoted. An attempt was made to introduce a new topic about once each week.

By assigning four problems each day, three of them were devoted to a review of topics with which the class was already familiar. Difficulties would continually arise with regard to the review problems which probably would not have been satisfactorily explained in the ordinary method of treating calculus. I am confident this method of assigning lessons was quite beneficial to the members of the class.

Results.

It is difficult to find tangible evidence to measure the results of the year's work. I have the results of the examination which was given to the class at the end of the year. In order to eliminate any prejudice which might make itself manifest in a set of questions that I would select as a test, I asked Professor K. D. Swartzel, of the department of mathematics, to set the examination. As a result of this test I gave an unusual number of high marks and a small number of average and below average marks, the number of conditions and failures being about normal.

Aside from the test, however, I feel confident that the members of the class have gained a much clearer comprehension of the meaning of calculus and of the significance of the operations of differentiation and integration than had been acquired by any class that I had ever previously taught. I feel also that they gained more facility in making all kinds of algebraic and trigonometric transformations. I believe they have acquired some confidence in their ability to follow, understandingly, mathematical derivations in all kinds of technical and scientific text-books. Most important of all is the fact that the members of class acquired some interest in the subject. Some of them even developed some enthusiasm in the working out of the daily assignments.

I have the testimony of Professor Smith that the members of the class took more than a passing interest in their physics. This too was noticed, during the second semester, by a laboratory instructor who was not in direct contact with the cooperation arranged between Professor Smith and myself. The students exhibited some desire to learn some physics rather than merely "get by" and obtain credit for the course.

The instructor in drawing states that the members of this particular class developed a more sympathetic attitude towards their drawing than is usually the case. They were not so much inclined to feel offended when their drawings were criticized, but exhibited a desire to learn how the work should be done.

In fact, there seems to be evidence to show that the members of this class acquired an improved attitude towards all of their work. A tabulation of all their credit marks for the semester just ended would indicate the class as a whole stands above the average. A comparison of these credit marks with the ones obtained by the same students during their first year shows a slight improvement in scholarship. This is not the usual result with respect to the work done by our students in their second year. Of course, the real test of this year's work with these students depends upon the quality of the work to be done by them during the remainder of their course. I am awaiting this development with confidence that they will render a good account of themselves.

CONCLUSIONS.

I believe that this year's experiment demonstrates that if a common, everyday setting can be given to mathematics, physics, chemistry and drawing, a setting with which the students are already familiar and then if these subjects are discussed in the language used by the students in their every-day life no difficulty will be experienced by the student of average intelligence in learning them. This is especially true if the student can be induced in some way to put forth some effort in trying to learn. This year's work demonstrates also that it is not necessary to enter the domain of practical engineering to find problems and illustrations to illustrate these fundamental sciences.

The two words "comprehension and application" express the essentials to successful learning. Too often one or both of these ideas are lacking in the case of our engineering students. I do not know that I have found the best way to introduce them, but I feel certain that the teaching of the fundamental sciences can be improved by approaching them from the point of view used by Professor Smith and myself in our experiment.

The members of the S. P. E. E. may be interested to know that four instructors at The Ohio State University are planning a similar study with a group of second-year civil engineers during the coming year.

DISCUSSION.

Louis Brand: When Dean Schneider returned from his war work at Washington, he set on foot a plan to have interior as well as exterior coöperation in the University of Cincinnati. To this end he organized a committee composed of representatives of the various engineering departments and of physics and mathematics. The business of this committee was to organize the courses of the first two years so that they would form a common basis for engineering in general, and to arrange the courses in such a manner that their natural points of contact would be emphasized. Upon examination of the curriculum, the committee found that there were two groups of courses which could be extensively correlated; namely, elementary mathematics, statics, and engineering drawing, in the first year; calculus, dynamics, and physics in the second year.

As an example of the sort of correlation attempted within the first group, a problem in statics may be reduced to the solution of triangles, and also solved graphically in a drawing plate. Again, the stresses in a derrick may be determined analytically or by the methods of descriptive geometry.

I think the correlations within the second group are sufficiently obvious. As examples I might cite the treatment of the laws of reflection and refraction, and the angle of minimum deviation of a prism, as problems in extremes in the calculus.

C. S. Howe: I do not wish to add to the discussion. May I ask a question? I have been very much interested in this paper of Professor Coddington's and I am going to say that some similar experiments are carried on in my institution, though not being carried on in my department. I understand Professor Coddington has assumed in this work that each student turns in an accurate statement of time spent in the work. And he also assumes that each student did the work himself without any help. I wonder if we can be absolutely sure that students do act in that way with regard to the work. The question I wish to ask is this, what was done in the other sections in calculus with regard to problems, and what was the custom before at the Ohio State? I want to get at the difference between the work Professor Coddington has been doing this year in his section, and what was done in the other sections, and what has been done in the past years. That may throw a little light on the subject.

E. F. Coddington: In answer to the last question I may say there is not much coöperation among the teachers at Ohio State University. My paper describes about all that has been done at our institution.

As to definite assignments, as a rule, classes are assigned at each recitation a more or less definite set of problems to be solved for the following recitation. The only check used by the instructor to determine if these problems have been solved by the class is to have each problem put on the blackboard by different members of the class. No systematic check is used to ascertain if all members of the class solve all the problems. If the truth were known, in many classes, no consistent attempt is made by all members of the class to solve all of the problems assigned.

President Howe asks the question as to whether I took cognizance of the fact that the students might not turn in the correct time put in daily by them in solving the problems assigned. I told the members of my class that I would expect them to be square and that the record handed in by them would be accepted as being correct. I think there were those who, on occasion, did not hand in correct returns. I told them occasionally that I was inclined to suspect some of the reports turned in.

The question is also raised as to whether all students worked out the solution turned in by them. They were frankly told that I expected each of them to make an honest effort to solve all of the problems assigned. They were also told that if some of them, after making an honest effort, could not solve certain problems they were to solicit aid, and that it made but little difference whence this aid came so long as it was legitimate aid. They were told, however, that they were not expected to hand in solutions which they did not understand.

I do not pretend that my instructions were followed in all cases. In fact, I know they were not in a few cases. The class was told occasionally that there were those who were handing in work not their own, and that they were cheating themselves and not their instructor.

The work done daily at the board, however, showed that practically all members of the class made an effort to solve all the problems assigned to them.

Homer L. Dodge: As a teacher of physics I would like to state that I agree with everything which has been said and believe that it applies equally well to my subject. But I do not think that the whole story has been told. We have had called to our attention the need of application and concentration on the part of the student and the value of well planned recitation and outside work but, for evident reasons, the speakers have laid no emphasis on the personality of the teacher. This, to my mind, is more important than the method.

Last summer through my work with the Committee on Education and Special Training I came to know Major Moore and Captain Duckering whose methods of teaching at Camp Humphreys have received considerable publicity. My conclusion was that the success of their methods was due in a great part to the personality of the men using them. A good method will help a poor teacher but a good teacher may be trusted to find an effective method.

It is the duty of the deans of engineering colleges to see that the courses in physics, mathematics, and other arts and science courses taken by engineers as a part of their prescribed work are taught by men who are qualified for the work through the right training, experience, and interest. Too much teaching of engineers is being done by men whose primary object is to get a doctor's degree and who are allowed and even encouraged to regard their teaching responsibilities as quite incidental. Moreover the teachers of these subjects must receive the proper recognition for this important work. Undergraduate teaching in our larger institutions suffers from the fact that it is not nearly as respectable to be an excellent teacher as to publish mediocre research. No one appreciates more than I the value of research for its own sake and for its effect on the man who does it. I do not advocate less emphasis on research but greater emphasis on the importance of good teaching.

F. H. Constant: I assume that Dean Bishop is serious in asking this question. The honor system at Princeton is a code of regulations drawn up and enforced by the students themselves. It applies only to written tests conducted in accordance with the code. The principal condition is that the test is to be conducted at a stated time, in a given place and in the presence of two or more students. A student is not supposed to leave the room during the test and he is required to write the pledge upon his paper before handing it in. The instructor does not generally remain in the room longer than is necessary to give out the questions and make the supplementary explanations.

In principle, therefore, the honor system at Princeton merely amounts to this, that the monitorship of the instructor is replaced by that of the students themselves. A student would probably not be permitted, by his fellows, to cheat, in the first place, but if he persists he is reported to the Student Council, who try his case. If he is found guilty he quietly drops out of college. Men do leave Princeton under these conditions, but such cases are not common. The honor system does work; we know by every sign that it does.

But while it is supposed to be in force only when all of the regulations of the code are being observed, the spirit of the honor system really extends far beyond the rules. It is difficult, sometimes, for a student to understand why he may not carry his paper to his room, or take a test in absentia. The safeguarding of the system, however, depends upon conforming rigidly with the regulations.

The success of the honor system at Princeton cannot be attributed to a different type of standard to that found elsewhere, but solely to the fact that it has been in operation so long that it has become part of the spirit of the place. Other colleges that are trying out the system should not be discouraged if it does not meet with complete success at the start. Time is needed for it to become deeply rooted in the student mind and to grow into one of the most cherished traditions of the student body.

A. H. Fuller: I had an opportunity to experiment a little on mathematics last year and, with the thought that these twenty minutes have been given over primarily to pick up stray bits of information, will attempt to sketch briefly what was done.

At Lafayette the time for mathematics has been divided between the class work by the mathematics staff and two three-hour periods a week given by engineering instructors. I had the pleasure of handling one of the laboratory sections during the past year. At first we kept in close touch with the class work by means of weekly conferences between the instructors. Later in the year we gradually assumed a freer rein and experimented as each instructor thought best.

We delved into mechanics a little and, finding the freshmen could readily pick up moments, gave a good deal of work involving moments. Then we tried a little calculus, not, however, going into the subject in the thorough way Professor Coddington has done, but more as an introduction to the sophomore work and subsequent applications. The student was told the result of the integral of dx with exponent n. No attempt was made to prove it. We used it getting areas, in getting volumes and in getting the center of gravity of surfaces and volumes. We purposely restricted the integrations to surface and volumes involving either the straight line or the parabola, but emphasized the idea of integrating between limits.

An effort was made to give the problems an engineering setting and it was a gratification to note the readiness in building up equations, integrating them bteween the proper limits and in securing correct results. It is a question, of course, whether the time thus spent was the most economically employed. While I am yet open minded I am optomistic enough to want to start other classes along similar lines while watching this one in subsequent work in calculus, in mechanics and in other applied work.

Professor Plant: I wish to say that I have been immensely interested in the papers given by Professor Coddington and Mr. Kiefer, and in the experience and testimonials of the different members of the society. During the past years I have attended the meetings of this Society quite regularly, and in conversation with you men from different institutions, I have heard statements like these: The people in physics say, "Our mathematics department does not teach our students what we think they ought to know so we have to teach them whatever mathematics they should know." The people in mechanics say, "The physics that our students get does not seem to be worth very much, so when we come to the subjects of velocity, acceleration, and so forth, we do not assume any knowledge at all, but start at the very foundation and build up the theory to suit ourselves."

So it goes all the way around. As I have listened to these two reports, it seems to me that the one lesson that might be learned from both reports is this, that just as soon as you can get the members of your departments of mathematics and physics to come together to discuss their problems, just so soon will you begin to get results, and just as soon as you can get your people in mechanics and physics or any of those allied subjects to get together to discuss plans by which each can be helpful to the other, you will begin to get results. It seems to me this is just exactly what is happening here. One of the reasons for the success of the work of Professor Coddington is that instead of the Department of Physics going out of its way to keep away from mathematics, it tried to see what Professor Coddington was teaching in order to develop those thoughts further and he in turn tried to back up certain things that the department of physics was teaching to see if he could carry those thoughts still further. Again I say, just as soon as you bring about a coördination, you can count on getting results.

As chairman of the Committee on Mathematics, I certainly hope that another year will bring forth other experiments, that we may hear what others are doing, in order to bring about more efficient teaching in mathematics, physics and mechanics.

Just a final word in conclusion. One other lesson that might be learned from the reports of Professor Coddington is this, that due to the very fact that he was experimenting and that Professor Smith was experimenting, each prepared his lessons very carefully. Now, I mean that with all seriousness. How many of us have gone before our classes knowing that we knew our lesson, that is to say, we know our mathematics, but we did not know just what we were going to say at this particular hour. When we are endeavoring to coördinate our subject with allied subjects we are bound to know the lesson of the hour and also save time.

REPORT OF CONFERENCE ON ENGINEERING EXPERIMENT STATIONS.

Chas. S. Howe: Mr. President, and Ladies and Gentlemen: It became evident, when the committee began to correspond about this matter, that it would be impossible to write a report to which we could all agree, and we were very much afraid that we could not write a report which would be accepted by the whole of the society. We wish to secure as much information as possible by getting your views on the subject. That is why we asked that a discussion be held this morning, in place of a Committee report. Doubtless all of you are familiar with what has been done so far in regard to the effort to secure Federal Aid for engineering research. As your president has just stated to you, this matter was brought to our attention by the engineering faculty of the Ohio State University, and so I will ask Professor Magruder, of the Ohio State, to present the subject to you, I call upon Professor Magruder.

W. T. Magruder: Mr. Chairman and members of the Society: I am sorry that Prof. F. C. Blake, the chairman of our local committee, is not here, as he is the proper one to put this matter before you, and particularly as I am not even a member of our local committee.

The experience of all of us who have been through the recent war is that there is very great need for engineering experimentation and research. I do not think there can be any chance for argument on this point. Those of us who are connected with one of the agricultural and mechanical colleges know that, as a result of agricultural experimentation, we have increased the value of the agricultural resources of our country many times, and that the farmers have been shown how "to make two blades of wheat grow where only one grew before,'' thereby greatly increasing their revenues. I do not think that it should be necessary to discuss the desirability of something being done along similar lines for both scientific and engineering experimentation and research. If that point is conceded, the question is, how best can those interested get the means to do the work and obtain the desired results. The answer heretofore has been that the way to proceed is the same way that the federal government has proceeded heretofore, namely by establishing engineering experiment stations, or something which will be the equivalent thereto.

Quite a number of different groups of people are interested in this particular proposition. We have the American Association of Agricultural Colleges and Experiment Stations, commonly known as the ''Land Grant College Association''; we have the Association of State Universities; we have the Association of American Universities; we also have the National Research Council which has recently been injected into the consideration and discussion of this problem; we have the federal government; and besides these, we have the general public which pays the bill. The question is with all of these six groups of people interested in the subject, what is the best way, or ways, to get the desired results by engineering experimentation and industrial research, which shall in some way approximate in value to the nation that already done, and being done, by the agricultural experiment stations.

As has been stated, the state land grant colleges are naturally and properly interested in these matters. Their argument is that they should continue the work begun by the government so as to round out their work. That seems to be a good argument from their point of view. The other state-supported educational institutions argue that they should have some chance to do engineering research work at federal expense, and for which they claim that they are well-fitted and qualified. The privately endowed educational institutions claim that in some states they are better prepared in facilities and man-power to do the work of engineering experimentation than it can be done by the land grant college of that state. One university president has even put forth the statement that the "three *athletic* universities, Harvard, Yale, and Princeton" also should have a chance to do the work!

Another type of interested group of citizens are those connected with the privately supported research institutions, such as The Mellon Institute at Pittsburgh, the National Canners Association, and others. Still another type of interested persons are those connected with the Research Divisions which are being conducted by many of our industrial and engineering corporations. Their argument is that if everybody should have a chance to spend a port of this federal money, why should not they? They claim that they are as well prepared as any other group of men to do the work, have more facilities, experience, training, and personnel, and should have the privilege of doing the work. From the above it will be seen that there are quite a number and variety of beneficiaries who might be willing to use part, or all, of any federal money that could be obtained for engineering experimentation and industrial research.

The next question is who should have charge of the disbursal of the federal appropriations obtained for such work, the decision as to what work should be done, the direction of the work, and the publication of the results. Until such time as we shall have a Department of Public Works which shall include the Bureau of Standards in the Department of Commerce, the Bureau of Mines in the Department of the Interior, the engineering part of the work now being done under the direction of the Office of (Agricultural) Experiment Stations in the Department of Agriculture, to say nothing of the other departments of the federal government now doing engineering and industrial research work and experimenation, who is to have charge of the money which will be appropriated and the work which should be done? Who is going to prevent some one in California spending money in trying to discover something which some one in Maine has already discovered? How is the federal government going to prevent the threshing of old straw? It will mean the establishment of some central headquarters' office and authority for guidance, direction, and control.

When these facts and ideas were presented to the faculty of the College of Engineering of The Ohio State University by its Committee on Engineering Experiment Station and Research, it became evident that the engineering profession was permitting a very serious waste of time and money in not trying to have done for the engineering profession what has been done for the profession of agriculture, namely the increase and advancement of professional knowledge to be obtained by engineering experimentation and industrial research. It seemed a very great pity to us at Columbus that these various associations and colleges cannot get together in a large statesmanlike way and decide how best to obtain the desired results, and then go before the Congress with one, and only one, bill to which there would be practically no opposition, and so obtain the needed federal appropriation for the work of engineering stations of one kind or another. That being the problem, it seemed to some of us at The Ohio State University, which is also a Land Grant College, that this Society for the Promotion of Engineering Education is the proper society to take the leadership among the various associations of the country interested in this subject, to unify their interests, to try to get them together, compromising details if need be, but to try to get them together into one unified organization which shall see to it that the federal government does unite with the state governments in having some engineering experimentation and industrial research work done in each of those states which desires to do such work and that adequate funds shall be provided therefor. With this end in view, our faculty memorialized the Executive Committee of this Society that a Committee should be appointed to consider this subject. That commitee has been appointed. President Howe is its Chairman. The problem is now before the meeting. This Society holds the key to the solution of the problem. Shall we use it? If because of local interests those in certain few states can not decide which educational institutions should have the opportunity and the responsibility for leadership in engineering and industrial research work in that state, why should those of us in the larger number of states and in the country at large be required to go without federal appropriations for the work? That is the problem before us.

For lack of time this morning, we can not have a long discussion of this subject. The question now before us is whether, or not, this Society shall take the leadership in the solution of this problem in a strong and statesmanlike way for the benefit of both the engineering profession and the industries of this country.

W. S. Franklin: Mr. President, I would like to make a suggestion to the committee. For many years in handling advanced students, we have all of us been under the necessity of referring them repeatedly, over and over again, to the German publications in which the latest developments in science have been adequately summarized. For example, take that remarkable book, Winkelmann's "Handbuch der Theoretischen Physik." It is one of the few things you can refer a student to for the latest aspects of various phases of physics. Of course, the Germans have been publishing books of that kind in other fields. It is almost impossible to refer a student to any adequate summary of the recent developments of science in English, and if we are to promote research in this country, I think one of the most important things is to provide for the periodic publication of complete summaries of recent researches in all branches of science, and the only possible way of doing it is to bring the government to see its duty in the matter of meeting the expenses. I do believe that a very large sum of money should be appropriated by the General Government and parceled by the National Research Council, or some other body, and that that council would have the authority to say to the leading man in any particular line of research that he was to summarize that whole field and would receive an honorarium for it, the publication to be at the expense of the government. If we are going to do anything, we must look to the young men, how to prepare them, and how to stimulate them for the work, and the adequate summary of the latest developments is one of the most important things to be done to help young men. I hope very much this committee will consider this thing.

W. J. Risley: I am going to suggest one thing as an outsider. The Agriculturals have been spoken of. The agricultural problem is local. The engineering problem is not local. You need an agricultural experiment station for the state of Ohio, and you need another one for the state of Illinois, and another one yet for Michigan, where the soil is different, and where the range is different, but as I take it, engineering problems,—and I believe that is the matter we are supposed to be discussing now,—are not local. The principles of bridge construction or reënforced concrete are more or less universal. I believe if this phase were kept, that with this proposed suggestion of control of a national character, we need not necessarily have two or three experiment stations in Ohio, and we need not have a half dozen of them in Illinois, and we surely need not have quite so many as we have of agricultural experiment stations. That is just a suggestion on the matter. The other suggestion is this; so long as a railroad can get a particular city to divide as to whether it wants its tracks up or down, it eggs the factions on and does nothing. I think Congress looks at it this way, one side demands one thing, and the other side demands it have exactly the opposite thing, and you cannot blame Congress which has plenty of places to put its money, when people who are experts cannot agree on how they want it done.

It was on that basis that I thought it was a good plan for this organization to concentrate its efforts and try to present a united front and show that we are really interested in the experimental work. For this reason, I think it is a good job if we keep our eye on that particular thing.

Professor Franklin: Mr. President, I would like to make another suggestion. There is one error we have all made in connection with the promotion of research. We have clung too narrowly to the idea of efficiency; we have been too much averse to the duplication of work. Now, if there is one thing that is needed in this country of ours to promote research it is to make scientific research a career for young men, to make scientific research a line of work in which a young man can make a living and bring up a family, and have his Ford machine to drive around in. It is the same in music, it is the same in every line. One reason we do not have music developed in this country is that a man either has to be an artist of the highest grade, or a fiddler; there is no middle ground. It is almost absurd to think of a man making a living in this country by his playing the fiddle unless he makes a fortune, and it is almost as absurd for any young man now to think of making a living in research unless he makes himself a T. J. Thompson, or a Helmholtz. What we want to do is to attract the young men of moderate abilities. No one knows if a young man has wonderful abilities until he is tried out, and no young man is going into a line of work in which, if he fails, he will starve to death. What we need, therefore, is something that will make it evident to young men that there is a possibility of an honorable career even if he does not make a wonderful name for himself in research. That being the case, duplication in research does not amount to anything at all. If we had a thousand men working continuously in this United States on Research problems in any particular line, many of them working on the same problem, you would get *more* than a hundred times as much done as if you had ten men working in that field. Therefore, don't lay such great stress on efficiency, don't lay such great stress on the elimination of duplication, except in so far as you have to do it when you are talking to Congress. Congress thinks it can pay out so many dollars for such and such results. You cannot do it that way. You have got to get young men to work, and feed and clothe them and maintain their families while they are doing work, and out of the whole you will get results.

I hope very much—and, of course, I am an outsider in this thing, so far as a state supported or national supported institutions are concerned—but I hope this movement will go through; there is nothing in the United States that is so much needed as adequate support for research, support, and not so much talk about it.

A. A. Potter: I agree with Mr. Wiley that the S. P. E. E. is a society where we can get together and forget that we belong to one institution or to another. It is undesirable for the society to step in and try to bring together the various factions. I am certain that this society will not succeed in bringing together the various factions who are interested in Federal aid for engineering experimentation. It would be very much better if the committee of the society would put itself on record as favoring Federal support for research, but not try to untangle a rather difficult puzzle. Consequently, Mr. Chairman, I move you that this committee concern itself only with the broad question of research.

Chairman Howe: You have heard the motion that the committee limit the scope of the work, and take no part in the discussion between the land grant colleges and state universities, as I understand the motion. Do you wish to discuss the question?

Professor Magruder: Mr. Chairman, this is one way to settle the case. I move, Mr. Chairman, as a substitute motion, "that it is the sense and opinion of this meeting that there is great need for experimentation, and second, that engineering research work should be conducted at the joint expense of the federal and state government." If I can get a second to that motion, I would like to speak on it.

Professor Franklin: I second the motion.

Chairman Howe: You have heard the substitute motion, which has been seconded, and is now open for discussion. It is on the question of the substitution that we are to speak, and not an argument on the motion itself. That will come after the motion has been made. Is there any one who wishes to speak on the substitution of this motion for the other motion?

Professor Magruder: I moved to substitute this motion for the other for the two reasons that I have already given. A third reason why the substitute motion should prevail is that this Society, representing as it does all branches of the engineering profession, and not just two or three colleges in this country, should be, and I think is, big enough, influential enough, and statesmanlike enough to get the contending institutions and associations together on this matter and prepare a bill to be submitted to Congress wherein fundamental principles involved shall be decided and not all the details. Are the members of this Society united in desiring federal assistance for engineering experimentation and industrial research work? If we are, do not let us shelve this opportunity for statesmanlike leadership. This is the chief reason for substituting the pending motion for the other.

C. J. Tilden: Mr. Chairman, I would like to ask if that cannot be changed somewhat, it makes no mention, it takes no account whatever of the large industrial research establishments that have come into existence in the last few years, and are being very widely expanded. A great many of those are available for coöperation with the schools, and it seems to me this is a rather hard and fast and limited, saying that research should be conducted at the joint expense of the Federal Government and the state. It seems to me that could be phrased rather more happily.

Dean Raymond: I think I have the same objection to the motion in the present form as has just been voiced. It contains a limitation. We are on record, the society is on record, as favoring Federal aid to engineering research. We passed such a motion at a meeting in Boston a year and a half ago. We already have that on our record. I think we ought not to accept this particular part of the motion, this second part, because it contains a limitation. I think we should stop with the statement that we are in favor of or recognize the need of engineering experimentation, that if we go on, we should simply add to that as we have already done, that we favor Federal aid.

Professor Franklin: Federal and State aid, any kind of aid we can get.

Dean Raymond: Yes, Federal and State aid.

W. O. Wiley: I had supposed the subject before this meeting was whether the Society should pursue any particular course or not, and not whether there was any value in any particular project of research or not. In council I have uniformly opposed this resolution. I have taken the position and it is only fair that I should take this position before the Society,—that our membership is composed of different elements and has different interests at stake. It seems to me a new departure for our Society to take. Perhaps the committee can come to an agreement on the matter before it is presented to the Society.

Chairman Howe: Do you wish to offer that as an amendment, Dean Raymond?

Dean Raymond: Yes, does that meet your—

Professor Franklin: I would rather the motion referred to the first phrase only.

Dean Raymond: It seems almost unnecessary to make such a motion as that.

Professor Franklin: I think so. Something like expressing an opinion of this body that ice cream is a pleasant food. However, that would not do any harm.

Chairman Howe: The motion is on both motions together, not separately, and there is no motion to change the present motion of Professor Magruder.

Professor Magruder: May I ask the gentlemen on my right,—there is nothing said about industrial experimentation. You and I can do just as much experimentation as we see fit, but the point is that the experimentation should be done by money provided by both the Federal Government and the State Government. The Mellon, the Westinghouse Electric Company, and many other companies, can spend money for their private experimentation as freely as they see fit.

Professor Tilden: My objection is to the phrasing of the second part, and I think that could be changed perhaps somewhat along the line Dean Raymond has suggested, to make it a little more conclusive.

Dean Raymond: I will move to amend that suggestion.

Chairman Howe: Will he read it again so that we will know the wording of the second resolution?

Dean Raymond: The second part of the resolution, that we favor Federal and State aid for such experimentations.

Professor Magruder: Will you make it engineering research?

Dean Raymond: Engineering experimentation, if you have it engineering research in the first part of your motion, we will have it in the second part.

Professor Magruder: I purposely put in both phrases so as to have it as broad as possible.

Mr. ————: We want Federal and State aid for whatever he was talking about.

Chairman Howe: Dean Raymond, will you read it as you have it?

Dean Raymond: May I hear the first part read?

Professor Magruder: That it is the sense of this meeting that there is great need for engineering experimentation,—and research. I am perfectly willing to add that.

Dean Raymond: This is a suggestion as an amendment to the second part, that we favor Federal and State aid for such experimentation and research.

(The amendment was seconded by Professor Magruder.)

(The amendment, being duly seconded, was carried.)

Chairman Howe: The original motion as amended is before you for discussion. Do you wish to discuss that?

Chairman Howe: Yes.

(The motion, as amended, being duly seconded, was carried.)

Chairman Howe: Does any one else wish to speak to this general subject? May I, as Chairman of the Committee, say a word with regard to the whole question?

It was suggested that we keep out of the discussion between the different organizations interested. Well, gentlemen, the committee is right in that discussion and it cannot get out of it. We have come to you for some help in the problem presented to us. We find that there are two bills before Congress, and that absolutely nothing concerning Federal aid for research will go through Congress as long as those opposing the bills are there. This is an absolute fact,—we are right up against it, and nothing can be done. Now, if you say this committee is not to enter into this discussion, you simply say you will have nothing to do with the question of Federal aid for research. Those two bodies have got to be brought together in some way, or there will be no Federal aid. I do not intend to speak upon this question because I want those directly interested to do so, but I am trying to tell you now where the committee finds itself. The association of land grant colleges has debated this subject to a great extent, has published a large amount of material in regard to it. Various efforts have been made to bring before Congress a resolution which would unite all factions, but they have finally, as their last word,—I think I am right in saying this because I have a letter from President Riggs which said they are going to stand behind their original proposition. They are in favor of no appropriation, as far as this particular bill is concerned, which does not give the whole matter in each state to the land grant colleges, and they will not change their position. As I understand, the state universities are very much opposed to such an action, and here is a committee trying to present something to this society which will finally aid in getting Federal money for research, and, gentlemen, you are not helping us a particle by anything you have done, except by a resolution, which is admirable. Is there any way by which the society can bring more pressure on the two bodies which are now fighting over this thing so that they will be willing to come together and by doing so secure help from the Federal Government for research. If they do not come together there will be no appropriation.

Dean Raymond: Mr. Chairman, I think perhaps you have answered your own question, when you quote from President Riggs. It will be very unfortunate to have this discussion come up on the floor of this organization. It should not be here at all. If your committee wishes to get information, it can get it by conference with the individuals concerned and interested. I think perhaps that would be a very good way. Some of us have prepared a measure which we think is fair, which we think is the proper thing to develop better aid for engineering research, Federal and State aid. Your committee is welcome to that. It has never been introduced in Congress as yet. It is not one of the two bills there. I think you have not asked for it until now.

Chairman Howe: I did not know you had it.

Dean Raymond: It is obtainable, and I think almost any fair-minded committee would consider it a fair proposition. I do not think Professor Riggs would.

I do think that simply by correspondence the committee can get whatever is in the minds of all persons concerned in this matter. I think as far as this particular body is concerned, the discussion ought to drop.

Chairman Howe: Dean Raymond, why shouldn't we have this bill here and read to the organization? The whole organization is interested in it. Of course, the Dean's statement in reference to a fair-minded committee may be a compliment or a slap at the committee. But I am sure the whole organization would like to hear the details of that bill.

Dean Raymond: I do not have the copy here.

Dean Hayford: I would like to raise one question in connection with the statement just made. It would indicate that it was a proper procedure for the Society for the Promotion of Engineering Education to appoint a committee to deal with a matter such as this, and deal with it absolutely autocratically in so far as the society is concerned, reach its conclusions and act without a discussion in the society as a whole.

That, it seems to me, is a dangerous sort of policy for the society to inaugurate. If this matter is one which the society cannot properly discuss openly and frankly, I doubt if it is a matter in which they should give a committee authority to act for them without a discussion, either before or after. I raise that question of policy. Is it a good thing to have a star chamber committee to deal with this matter if it has one which cannot be dealt with in the open meeting?

Mr. W. O. Wiley: The subject under discussion has already been brought before the Society. In fact, at our meeting in Boston in December, 1918. We had the privately endowed institutions represented by Pupin, of Columbia, and Maclaurin, of the Institute of Technology. We had the Land Grant Colleges represented by President Thompson, of the Ohio State University. We had the state universities represented by Dean Raymond, and there were a number of outsiders who took part in the discussion. My opinion was formed from the arguments pro and con in that meeting, that this Society could not bring the opposed elements together and that it is not a proper task for us to undertake as a Society.

C. G. Brown: Mr. Chairman, my understanding is that an engineer is one who can try to solve a problem by first finding the facts and then reasoning from those facts to a clear and logical conclusion. If we, who believe in the promotion of engineering education, cannot do that, it would seem as though we are hardly competent to instruct others in

Engineering. Now, is it not possible for a body like this to lay aside personal prejudices or personal opinions and to come to the conclusion that such methods are logical and sensible? In other words, it seems to me that we must, as a society, admit that some particular course which can be divised is the course which we are willing to back unitedly in its presentation to Congress. So I would favor emphatically this society taking a stand in a united manner before Congress. It seems to me that it must be possible with the number of engineers that are available for work of this kind to find a solution that would at least appeal to the mind of the engineer, even though it does not appeal to the mind of the person who wants the money for his particular institution.

D. D. Ewing: Mr. Chairman, I agree with Dean Raymond that this matter is hardly one mete for discussion here. It sounds to me as though this meeting was headed toward one discussion university administration, and if that is the case, I think we are out of order discussing it. I think, speaking as a land grant college man, that the land grant colleges know what they want pretty well. The trend of this meeting is toward something which the administration authorities of the land grant colleges may not approve. In other words, we are being asked to get together and vote on something which is not likely to meet the approval of our superior officers.

Secretary Bishop: Mr. President, I come from a section of the country which is vitally interested in Engineering Research. Personally, I have the supervision of the research of a very large corporation. In connection with that work there are many factors which we would like to have determined, and which should be determined by Federal and State aid and not by individual corporations. Information so obtained should be public property and not private property. I have in my files results which would be of immense value if they had been obtained through Federal or State aid. They are now the private property of a company. I take it, in discussing this matter with the representatives of large corporations, that Federal and State aid is going to be given to research.

Now, it is not at all necessary that either land grant colleges or state universities have anything whatsoever to do with the Federal and State Research Experiment Stations. I hope that question will not come here at all. I do not want to see this problem—although I have discussed it with Dean Potter and Dean Raymond and others—I do not conceive that the problem which comes before this society is one of the adjustment between the land grant colleges and the state university, but it is one in which all teachers of engineering must be vitally interested. Our whole profession is based on research. This country lagged behind in research up to very recently, due to the lack of coöperation of the Federal and State Governments in engineering research. The big corporations are developing research laboratories with amazing rapidity. The information obtained in these is private and confidential. It should be public. Surely there is no organization in the world so much interested in the development of research and Federal and State and of research, as this organization. I hope that this may be discussed, not simply at this session, but at a good many sessions, until some logical development, some logical solution of this matter can be reached. I am reliably informed that the present Congress would pass a Federal Aid bill of engineering research if a group of men, such as this, vitally interested, that knows the problems of engineering research, presented a proper solution. Surely, we are not going to overlook an opportunity as great as this. I do not conceive it has anything to do with any type of institution. It is a big, separate problem. The society is for the promotion of engineering education, based upon engineering research.

F. W. Sperr: Mr. Chairman, I think it is very unfortunate that the question of to whom these funds should go has been injected in this question. I wonder who said that the fund should go to a state university or the agricultural colleges, or to institutions, of the type of the Mellon Institute. These questions, I conceive, this society has nothing to do with and should not consider, but the questions should solely be put on Federal aid for engineering experimentation and research, and let those who give the aid, or some government authority, designate where and how that research should be conducted, and let it be public property, as Dean Bishop says.

Dean Raymond: Mr. Chairman, Dean Cooley, was unable to find a copy of the proposed measures, and suggests that I state the fundamental differences between this measure and the others that have been presented. I am not sure that I can do that entirely from memory. I have not seen the measure for some weeks, but the fundamental principle is that Federal aid should be extended to the individual and the institution having a problem to solve that is deemed to be worthy of solution. The proposition is to finance the individual and the job, when the individual and the job appear, whether it be in industry, in a privately endowed institution of learning, or a publicly supported institution. It is folly, I think,—at least we thought so in formulating this bill,—to spread broadcast a certain amount of money over the country to be frittered away, here, there and the other place, where work in this line is not done, or where the persons do not exist competent to do what is to be done. Not everybody is competent to do research. There are only a few people who can do that sort of thing.

Dean Cooley seems to have found this bill. It is somewhat marked, and I am not sure whether it is the last form or not.

That is the substance of the bill. It puts the matter up to the only National body I know anything about that is competent, to decide general questions. It takes it out of politics, so far as it is possible to take it out politics, and removes the whole matter from institutional jealousies or differences, and as far as I can see, it does, as suggested by Mr. Magruder, make a statesmanlike document in so far perhaps as an engineer is capable of writing such a document.

Chairman Howe: Although the close of this discussion has arrived, I have asked the President to permit me to say a few more words from the floor after he has taken the chair, and he has finally agreed to do so.

(President Greene resumed the Chair.)

President Howe: Of course, as chairman of the Committee, I have had to think a good deal about this question, and it seems to me the committee is up against these special bills and can not do anything with them in the way in which they now stand, and I have been interested, as has Dean Raymond, and a number of others, in this aspect of the question.

I am speaking for myself personally, not for the committee, because the committee has not had a meeting. It seems to me this organization is interested in engineering research, and, therefore, can well take up this question. I wish we might discuss it entirely from the standpoint of research and not from any selfish consideration. When I say selfish consideration, I am not using that word in a critical sense. It is evident that the bills which have been introduced in Congress are selfish bills, that is, they are intended to promote the interests of certain institutions.

Is it possible for us to get away from that in discussing research, and take the whole subject in a manner which will best promote research, and will not promote anything else. Dean Raymond's bill covers part of this. It does not cover every thing I have had in mind. I wish to say a word about what I have thought of. The latest bill proposes that $30,000 be given each year to each state. That means that forty-eight states must each find a man who is a strong man in research. Personally, I do not believe that they can do it. A big research man is a rare thing in this country, and I do not believe every institution has a strong man to take charge of research. Again, when a strong man is found he must be paid a good big salary. When we consider everything that must come out of the thirty thousand dollars, it will not amount to very much for research. It will be a mere bagatelle, is will not amount to anything at all. We must have large sums of money if we are going to carry on research in a big fashion as this government ought to do. I would like to see a research department started with headquarters in Washington, something that would be like the Bureal of Mines, or the Geological Survey, or the Bureau of Standards, a great organization with a large sum of money placed under its control, the use of which would not be confined to any one state, or any one section of the country. Then I believe we could get some big results in engineering research. I would like also to see that organization given authority to establish substations in different parts of the country. If there are problems peculiar to the Pacific Coast, why should not a substation be established along the Pacific Coast, but entirely subordinate to the Bureau in Washington? If there is a problem peculiar to the Southern states, why shouldn't there be a branch there? At the same time I would like to see that body given the power to assign to any institution or any person in any part of the country problems which they or he were particularly qualified to solve. It has been said here that one of the difficulties of research work is that we do not know what is going on in other places. If there is one organization in charge of all these matters, we shall know because the publications will tell us what it is going on, and in that case, there will be no useless duplication of research. It would seem to me that we would then carry on research in the broadest kind of a way, and we would have a research bureau of the same sort as the other bureaus at Washington which conduct governmental business on a large scale. There would be no selfish consideration in this, because it would not affect any individual or institution for his or its benefit. Let me say again these thoughts are mine and have not been acted on by the committee. In fact, I have not spoken to the committee in regard to them.

Dr. A. L. Williston proposed the following resolution which upon motion was accepted:

"*Resolved,* That it is the sense of this meeting of the Society for the Promotion of Engineering Education that the Committee on Engineering Experimentation proceed with its study of plans for the furtherance of Engineering Investigation and Research, and that it endeavor to harmonize the difference of the existing plans for this purpose, if possible, or if this be found impracticable, that it recommend some plan of its own for consideration of this Society at a future meeting."

ENGINEERING RESEARCH.

BY ALBERT E. WHITE,

Professor of Chemical Engineering, University of Michigan.

For many years it has been well recognized that two distinct functions of a university were the training of youth and research. Just why research has been considered a desirable and necessary function of university activity is possibly problematical. It doubtless grew out of the belief that the university is the source of information and that new information and accuracy of all information can only be ascertained and checked by research.

Preceeding the outbreak of the Great War the value of high grade research work, the results of which might benefit humanity directly, was beginning to be appreciated. It was customary for most colleges and universities to accept fellowships on condition that the subject of the same was one jointly chosen by the donnor and the university. Many of these fellowships assumed a distinctly practical tone though the solutions of the problem, or problems, involved work distinctly technical and scientific in character and called for scholarship of a high grade.

This class of research work received a distinct impetus during the progress of the Great War. Practically all of the trench warfare material, practically all of the chemical warfar material, and much of the work in aircraft was based on the results of research. The same is true with regard to the development of tanks and tractors and improvements in heavy artillery, although these latter were of a much less spectacular character than were those just previously mentioned. These researches involved the expenditure of millions, yes billions of dollars. Much of it, we must admit, was wasted if we consider the results obtained but if we appreciate the conditions under which it was necessary to carry on this work it is questionable if any sound thinking, patriotic American citizen would for one moment consider that one cent of this money had been wasted. Such waste as there was we can charge back to ourselves for permitting other nations to be more fully informed with regard to matters on which progress and safety depends then were we.

At the signing of the Armistice, everyone realized the significance and the truth of the statements just made. We were then all keen for research work. We realized the mistakes we had made in not enabling our government to perform research work at a time when the same could be carried on in a sane and thoughtful manner. Manufacturers in Michigan appreciated this condition so strongly that in February, 1919, the Michigan Manufacturers' Association brought to the attention of the regents of the University of Michigan the desirability of establishing closer relationship between the university and the industries of the state, realizing that in so doing an appreciable degree of coöperation would be through the channels of research. This same matter had been brought to the attention of the regents in June, 1916, by the University of Michigan's Chicago Engineering Alumni Association but the stress of the times followed by the early entrance of this country into the world war prevented the regents from giving this matter consideration until the same was again brought to their attention by the Manufacturers' Association.

In answer to the memorial of the Michigan Manufacturers' Association the regents appointed a committee to consider the question of coöperation and this committee prepared a report recommending that the same be made effective. The report of this committee was acted upon by the regents in January, 1920, and since that time there has been going on progressive, but quiet organization work with regard to the development of this department. The essential features of the committee's recommendation were the appointment of a director, an administrative committee consisting of the heads of the civil, mechanical, electrical, marine and aëronautical engineering departments and the head of the department of architecture and architectural engineering, and an advisory committee consisting of approximately one hundred persons selected from among the leading manufacturers of the state. This committee of one hundred has already been selected and its personnel has been so picked that practically every important industry in the state has representation and practically every important industrial center in the state is represented. This committee had its first meeting on May 27. The purpose of this meeting was one of organization and acquaintance of the members of the committee with the university and its equipment. It is expected that numerous meetings of this committee together with a committee of the regents will confer during the summer for the purpose of perfecting details regarding the department.

Just what those details will be are at present more or less a matter of conjecture. It is quite probable, however, that the university will not deem it advisable to accept any research work, the results of which can not be made public nor will it accept research work the results of which would be subject to patenting for private interests.

Doubtless many of you are wondering how this department will be financed. That is a question some of us even, who are intimately connected with the work, are asking. We are asking it not because we have any doubt regarding the financing but because the method which will be employed is one for deliberation and consideration. There are a number of ways for bringing this about. One is by a special appropriation by the legislature in case they appreciate the needs for research and we have no reason to believe at the present time that they do not so appreciate the needs. Another way is by subscriptions received from among the manufacturers of the state and the third is by joint action of the state and the manufacturers. A fourth is one resulting from the gradual development of the department bringing with it increasing fees and funds which will enable the proper carrying on of the work. It is quite possible that this latter procedure will be the one employed at the start although it will doubtless not be long before proper facilities for the carrying on of extensive work will be necessary and to obtain these one of the first three procedures mentioned will be necessary. However, the matter of financing is not one on which those of us engaged in teaching at the university are giving deep consideration for we expect that the advisory committee will give good sound council on this matter and that they, in conference with the regents, will be the ones who will determine the procedure proper.

Various parties have asked whether or not the work of such a department would not duplicate work done through various government channels such as the U. S. Bureau of Standards, the U. S. Bureau of Mines, the Department of Agriculture, etc. To those who have raised this question, we would say that it is not the purpose nor the object of this department to duplicate any work now being carried on. Those of us who are in touch with manufacturing know the tremendous developments which have taken place in it in the last few years and realize that with this development there have been increasingly greater numbers of research problems presented.

It is not the purpose of this department to undertake work which is of a routine character because it believes that each individual establishment can carry on such work to better advantage than can this department.

There is no question in our minds but that educational institutions have been backward with regard to their relationship to industries. Our agricultural colleges have been doing excellent work in their relationship to the agricultural needs whereas there have been few endeavors on the part of universities and engineering colleges to coöperate with industries. This condition is true in spite of the fact that the wealth of the country has increased many fold from its industrial work. For example, the value of manufactured products in the state of Michigan in 1914 was $1,086,162,432. In 1919, just five years later the value of manufactured products is estimated at $2,600,000,000. These figures are given not because they relate to Michigan but because they happen to be available and illustrate the point in question, namely, the great value of industrial products. That we have been laggard in our coöperation is due to both the industries and the universities. The one has been so busy creating wealth that it has not realized the vast store of possibilities in our universities and the other has been so engaged in the educational program of the youth that it has not found time to study industrial needs.

To be sure we must realize at all times that the education of our youth who come to our universities and colleges must be properly safeguarded. It behooves those in authority, such as our deans and our presidents, to see that in coöperation between the industries and the universities, our youth do not suffer. Those of us who are following the work at Michigan anticipate that through additions to the staff and through definite assignments of work, the youth in our university will be benefitted. They will have contact with bigger, abler, and broader men and they will have facilities in the way of equipment for the carrying on of research in the magnitude to which the field is entitled, which they do not now possess.

This has been a brief presentation of the subject. No attempt has been made to speak of research work in general throughout the country, in fact that matter has been very ably handled in a paper presented by your president before the American Society of Mechanical Engineers in June, 1919. This presentation has been confined quite largely to conditions as they exist at the University of Michigan. The matter is presented in the hope that some of the statements made may be of assistance and value to all of you whom we know are giving so much time and thought to this matter.

A COÖPERATIVE COURSE IN ELECTRICAL ENGINEERING CONDUCTED BY MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND GENERAL ELECTRIC COMPANY.

BY W. H. TIMBIE,

Associate Professor in Electrical Engineering, Massachusetts Institute of Technology.

The educational scheme known as the Coöperative Plan is not new in itself. That there are distinct advantages in acquiring theory and practice at the same time has long been recognized, and several technical schools, notably those abroad, have been operating on this plan for several years. The College of Science and Arts in Glasgow, the Faraday House in London, and the University of Copenhagen in Denmark, are well-known examples. In this country we are indebted to Dr. Herman Schneider for inaugurating the coöperative work at the University of Cincinnati. Courses similar in detail have been operated by the University of Pittsburgh and by Marquette University at Milwaukee. The only excuse we have for coming before you with the Technology Coöperative Course in Electrical Engineering is that it differs in several important respects from the coöperative schemes of other institutions. It is these differences that I wish to call to your attenion, and explain reasons for their existence.

It should be said at the very beginning that the coöperative course herein described was not planned for the purpose of training electrical engineers in every field; and it does not take place of our old and well-established electrical engineering course, but is an addition thereto for a collateral object. In fact, at present its scope is rather limited. It is avowedly an effort at intensive education and training of electrical engineers to meet a specific demand. Perhaps the easiest way to describe just the field that these men are being trained for is to consider for a moment the various fields in which electrical engineers are needed. We can roughly divide electrical engineers into three rather arbitrary divisions:

First, the consulting engineer, who is usually attached to one or more electrical companies or users of electrical power, to advise them in cases where expert electrical knowledge is needed.

Second, the administrative engineer who may have a large financial responsibility in addition to his duties as electrial engineer. Such a man would be called upon to take the responsibility for the electrical end of any project in the development and utilization of electrical power. In fact, both of these first two types are more closely connected with the development and administration of projects for using electric power than with the manufacture of the machinery involved in such projects and are in fields which are of themselves of tremendous magnitude, breadth and importance.

In the *Third* division, then, belongs the engineer who is intimately connected with the design and manufacture of electric machinery and accessories. He superintends the design and manufacture of most of the apparatus used by the other two types. His qualifications call for an intimate knowledge of the best manufacturing processes and a thorough training in modern research methods—to which must often be added the ability for creative design. This is the engineer that the Massachusetts Institute of Technology is endeavoring to train by means of its coöperative course in electrical engineering.

And he is not confined to manufacturing electrical appliances. This is the engineer that will be needed in ever-increasing numbers as the country turns more and more to the manufacturing industries in order to sustain itself. The alarming rate at which the natural resources of the country are being depleted has made it imperative that the country at large eventually rely almost entirely upon its manufactures.

No longer can we depend upon our exports of raw materials to pay our bills. These raw materials—lumber, ores, and oils—must be manufactured into finished products if the living expenses of the population are to be met. Our water powers must be utilized and new methods of using our oil and coal more efficiently must be devised. In all this work, manufacturing engineers of the highest type are needed, and become the most valuable asset of the country. It is these men who in the last analysis must direct the operation of the nation's industries. For our industries cannot compete with those of other countries unless they are conducted by men who have large vision, intimate knowledge of manufacturing details, and a thorough training in science and scientific methods. Manufacturing must be conducted on a sound financial basis, which means that processes of production must be so managed that the total cost of the finished article will be low enough to compete with the products of foreign factories. For this task the services of an engineer who has a thorough knowledge of manufacturing processes are invaluable and his duties multifarious. He must not only be familiar with the best methods of production, but he must thoroughly understand scientific research, in order that he may take advantage of new discoveries and continually better his methods of production. This cannot be stated better than in the words of the Governor of Massachusetts, Calvin Coolidge. "Our prosperity comes from our industry and our industry cannot flourish unless it is directed with the highest intelligence. Far more in the future than in the past will this intelligence call for sound training in science and in its innumerable applications to industry."

The General Electric Company, as well as other large manufacturing concerns, for years have felt the lack of this type of engineer. They have endeavored to train up in their own organization a corps of men sufficient to fill the ever increasing number of positions of this kind. Now the General Electric Company employs 65,000 men and yearly puts out a manufactured product whose market value is over $250,000,000. From these figures you can gain some idea of the quota of manufacturing engineers needed by this one company. The normal growth of the company averages 18 per cent per year. To take care of this increased business there is needed an increased force of engineers. When we add to this number the inevitable replacements necessary each year, some idea is gained of how great is the task of training a sufficiently large corps of these high grade engineers. Every large manufacturing concern admits its inability to obtain a sufficient number of these men to meet the yearly demand, especially as the graduate from the usual mechanical engineering and electrical engineering course requires much additional training and experience before he is a good manufacturing engineer.

The coöperative electrical engineering course at the Massachusetts Institute of Technology is an attempt on the part of the General Electric Company and the institute to solve this problem. In this plan the students have the advantage which the institute offers in the way of theoretical and technical training combined with the enormous resources which the General Electric Company offers for practical experience in the manufacture of electric appliances. Most of the theoretical training is given at Cambridge. The greater part of the practical training is given at Lynn, a distance of about ten miles from Cambridge. The course is supervised by a joint committee of the institute and the company. A professor of the institute is associated with an officer of the company in the duty of supervising the progress of the students while at the Lynn Works.

The course covers a period of five years, the first two years being identical with the regular course in electrical engineering at the institute; the last three years being divided between the instruction in theory at the institute and training in manufacturing methods at the General Electric Company. The coöperative features thus occupy only the last three years, starting in the summer after the sophomore year.

While at the works the students are given a fixed payment per week as employees of the company, which payment is the same whatever department of the works may be the one to which the student is assigned. At the completion of the five years course the students receive the Master of Science degree and the Bachelor of Science degree their graduation taking place at the regular commencement time at the institute.

The first class was limited to thirty members. The class which enters July 6 this year will consist of sixty. The size of future classes may be still greater.

The first week in July, the entire class who have just completed their sophomore year are sent to the General Electric Company's works at Lynn and placed in various shops. Here they remain for thirteen weeks. At the opening of the fall term at the institute, one half of the students return to Cambridge and pursue for one term what is practically the regular course in electrical engineering. At the end of this term they have a vacation of two weeks and then go back to the works of the General Electrical Company for further experience. The other group now returns to the institute for further theoretical instruction. This schedule is carried out for three years, each group spending alternately thirteen weeks at the General Electrical Company's plant and eleven weeks at the institute. The vacation of two weeks given the students at the end of their period at the institute divides the year into four equal periods of thirteen weeks each. The last period of the fifth years, is spent by both groups at the institute so that the two groups graduate together at the regular commencement time. Yet each group has spent an equal number of weeks in theoretical instruction and practical application.

Now as to the points of difference between this and other coöperative courses. No doubt, on the surface, the most striking feature is in the length of the periods. This, however, is perhaps the least important difference. It was endeavored to arrange the details of the course so that they would fit into a system of education which the founders believe is basic.

This system combines the rudiments of Spencer's theory of education with the central idea of Josiah Royce's. It is an endeavor to develop all the desirable sides of a student's mind, character, and body, and at the same time inculcate in him the spirit of loyalty to his life's work. The course had to be planned so that these several activities would be carried on uninterruptedly throughout those periods which the student spends at the institute and at the works. You will note that in the scheme as outlined, the following activities are carried on continuously throughout the course: Instruction is given in theory, classes are conducted in some humanistic study, time is given and facilities provided for collateral reading, and arrangements are made for physical exercise and recreation. The change therefore at the end of each period does not mean so much a change in occupation as a change in emphasis and the length of the periods thus becomes a rather unimportant detail.

The period of thirteen weeks at the shop and eleven weeks at the institute followed by a vacation of two weeks, was decided upon for the following reasons. It was believed that the period at the works should be long enough for the student to spend in each department an uninterrupted period of sufficient length to become thoroughly familiar with the men. methods, materials and spirit of that department. In some departments the time required for this amount is practically three months, and in others it may be as low as one month. The thirteen weeks' period will therefore meet the conditions required for those departments in which he must spend the longest time and does not prevent him from dividing his time among two or three departments in case he is able to master the details in a shorter time. The same is true concerning the length of the period at the institute. The shortest course at Technology is ten weeks in length, and all longer courses are some multiple of ten weeks. The student is thus able to pursue his studies at the institute in units of standard length. Furthermore, the fact was not lost sight of that at each change some time was lost by the student in getting started on the new work. Therefore, the periods were made of sufficient length to keep the number of changes as low as practicable. Finally it was hoped that the length of the period had been so chosen that the sojourn at the works would come as a sort of mental relief and recreation from the term's work at the institute. In fact it was hoped that toward the end of the term's work the student would begin to look forward to the change as a welcome break in the routine of study, and on the other hand, that the length of the period at the works would be sufficient to quicken his desire and appetite for further mental concentration and study. The fact is, the thirteen weeks' period has proven that these results have been accomplished. But whether or not a somewhat shorter or longer period would produce the same results has not been experimented with, because the period of thirteen weeks fits into the institute calender in such a way that the periods spent at the institute are practicably coincident with the regular institute terms. So much for the length of period.

The real vital difference, it seems to me, between this course and other coöperative courses conducted in this country, is the fact that the coöperating company recognizes that for three years these students are placed in its plant for the particular purpose of being educated and trained as electrical engineers of a particularly high grade. There is not the slightest effort or inclination on the part of this company to use these students for the purpose of getting out greater immediate production. It is clearly understood that these students are in the shops and offices to learn, and to learn thoroughly, manufacturing methods, and the best relations of labor, mechanism, and materials in high-grade production. Because he can best obtain this knowledge by actually doing the work himself, and because the skill which he attains in any process is the only fair indication of his knowledge of that process, the student is put on the company's pay roll and becomes part of its organization. The length of time spent in each department is regulated not by the needs of that Department but by the value of the experience to the student. As soon as it deemed that he has all the knowledge of the details of the department that a manufacturing engineer should have, he is immediately changed to another department. This change is made upon consultation between the foreman of the shop, and the officer of the company, and the professor of the institute, who are associated in conducting the course.

It is not to be inferred from this statement that the coöperative students do not work as earnestly and as consistently as the other men in the various departments. The coöperative students are graded on the amount and the quality of the work which they do in the various shops and as strong inducements to do good work are put before them as are put before the regular workmen. The only difference between their work and that of the other employees is that the students' work is so laid out that they receive a maximum amount of experience from each job and they are kept at it just long enough to enable them to become fairly proficient in the necessary operations. In this way the minimum amount of time is spent in learning the details of manufacture in the different shops, testing departments, drafting rooms and engineering offices.

This spirit on the part of the coöperating company, it seems to me, is the fundamental contribution which this coöperative scheme offers to engineering education. All the other points of difference between this and other coöperative courses are made possible and have their origin in this spirit of the General Electric Company, which we believe, is the true coöperative spirit. It is the one factor which has allowed us to carry out the plans of the originators and to make such innovations and experiments as we believe will improve the curriculum. I will speak about a few of these innovations more in detail later, but I want it clearly understood that it is not these changes and departures from the ordinary curricula which are the important things in this course, but rather the real coöperation which the General Electric Company has offered us. Do not think, however, that this company has an unselfish motive in this work. The officials of the company frankly con-concerns in the near future. It was because they believe that by this method they can procure the future engineers who will be so badly needed by the company and by other industrial concerns in the near future. It was because they believe that this is the best way to secure these men that they have entered into this scheme, and after one year's trial they report that they are more convinced than ever of the value of coöperative education conducted along these lines.

Perhaps the spirit in which the work is being done is most clearly manifested in the attitude which the officials of the company are showing in their lectures on manufacturing methods. Once a week one of the superintendents has the students come to his office and, in an informal way, talks to them for an hour concerning the details of the work of which he is in charge. This feature was introduced into the course at the suggestion of one of the superintendents and is given entirely upon the superintendent's own time. Some of these men have already prepared six or seven talks on their work, many of them illustrated with lantern slides; some have prepared exhibits of the work in the shops, showing the material in the different stages of manufacture, and arranged in order of the process. Others have arranged to have the students come to their shops in small groups in order to follow through the manufacture of some typical article of their product so that the students may become familiar with the output and the processes before the lecture is given. When one stops to think of the amount of labor and time that is involved for the superintendent who does these things, he can appreciate how the spirit of the originators of the course has permeated the personnel of the works. It also has entered into the attitude of the workmen themselves. I have been surprised, and, I assure you, agreeably surprised, to receive rose-colored reports from the students concerning the willingness of the workmen to help them obtain information about the plant. It would seem impossible for twenty-eight different personalities to mingle with the men of the shops and offices for a whole year and to have not one of them report cases of grouchiness on the part of the other employees of the company. But such has been the case. In fact, the boys report that many times they are embarassed by the extreme courtesy and eagerness of the men to show them all about the work and to demonstrate and explain the details of particular processes. All these things, it seems to me, show the degree to which the company has entered into this scheme as a purely coöperative project.

Of course, you must also appreciate that the students have done their share in coöperating. They have in every case entered into the spirit and work of the shops and offices and have quickly become a part of the company. We have paid particular attention to impressing upon the students the great factor which human engineering plays in their chances for success. They are impressed with the fact that nothing is of more importance than to understand the sterling qualities of the men with whom they are working, to study and learn how to adapt themselves to the personal characteristics and eccentricities of the various foremen under whom they are working—that these things will be of the utmost importance when they are in a position to direct the work of others. So during their sojourn at the shop they get experience not only in electrical engineering but also in human engineering and each man's progress along this line is followed carefully by those in charge of the course. Do not get the idea from this, however, that the students are in any way coddled. Here is an excellent chance for them to learn to stand on their own feet with all kinds of fellow workmen and all kinds of foremen, and they are compelled to do so. Of course, they make mistakes and occasionally get into trouble, but it is better for them to make mistakes and get into these few troubles while they are still students under the supervision of the instructing staff of the plant and school rather than later. Each mistake is used as material to impress upon them the value of human engineering. They are thus able to learn valuable lessons without having to suffer too seriously from the mistakes.

Great credit belongs to Mr. Magnus W. Alexander, whose initiative was a principal force in the origination of the plan, and to Mr. C. K. Tripp, Superintendent of Apprentices, of the General Electric Company, for the excellent work they have done along these lines. They have worked out highly successful methods for utilizing in the most practical way all the opportunities which the shop work affords for education and training in the human aspect of the job. To be sure, they have thrown themselves enthusiasticallly into all activities of the work and have brought to the task experience of twenty years in training executives. But in the development of the human side, I believe they have contributed a particularly valuable feature to the educational program of engineers. This discussion is a little aside from the point I was trying to bring out, but I believe it shows how the far-sighted policy of the Coöperating Company allows us to broaden the traning in every desirable way.

As the third point of difference from other coöperative courses, I will mention the continuity of the theoretical studies and humanistic subjects. All through the course, both while at the institute and during his sojourn at Lynn, the coöperative student is pursuing the study of electrical engineering theory. At the same time he is taking courses in the study of English. While the main purpose of the latter is to train the engineer in more effective speaking and writing, it also affords opportunities for enlarging his vision and creating new interests. Accordingly when a student goes to the works he continues the study of electrical engineering just as though he were at the institute. During this period, however, we have found that he can comfortably cover only about half as much ground as he would in a like period at the institute. This schedule calls for six hours of study per week and three recitation hours for the two subjects, electrical engineering and English. Thus including the one hour lecture given by the shop superintendent each week, the students spend four hours per week in recitations or lectures. Their schedule at Lynn, therefore, comprises the following:

48 hours per week in shop or offices,
4 hours per week in class room work.
6 hours per week in preparation for class room work.

This schedule allows the student to do all his study in three evenings a week and yet get to bed at half-past nine. There is still left for him three weekday evenings, Saturday afternoon, Sunday and Sunday evening, for collateral reading and recreation. At the institute his schedule calls for a total of forty-eight hours per week in class room and preparation. Thus while he is at the work the student's weekly schedule is increased from forty-eight to fifty-eight hours of a combination of shop work and mental work. This schedule at the works has proven of advantage in two ways—it has made the period at Lynn contribute to the student's technical knowledge and literary appreciation, and at the same time has kept him in the pink of condition mentally. The scheme may be compared to the system of physical training in which intense physical exercise is alternated with periods of lighter but regular exercise, which keeps the athlete at all times on the tip of his toes. It has been one of the most gratifying results connected with the work to find that our fondest hopes in this direction have been fulfilled. Members of the instructing staff at the institute have commented upon the fine mental condition of the classes returning from their thirteen weeks' stay at Lynn. I believe the opinion is unanimous among their professors that these students are wide awake, have acquired a keen appetite for study and are entering into their work with a new zest. In short, they have what the boys call "pep."

Inasmuch as the material used in the study of English and the method of conducting the English classes is unique, I believe a word concerning this work would be interesting. It is a well known fact that engineering students as a class have an aversion to the study of English for its own sake. So it was felt necessary to arouse an interest in this work before starting it. A plan which was conceived by Professor H. G. Pearson, head of the English and history department at the institute was adopted. At the first session, letters from successful graduates of the institute were read to the class. These letters all brought out the fact that the higher the engineer rises in his profession, the greater is his need to be able to speak well and to write well. Several instances were cited where promising engineering projects were turned down by committees or boards of directors because the engineers back of the schemes were unable to present their side of the case effectively, while a lawyer who knew nothing about the engineering features was able to talk effectively and persuasively. The class was then formed into a committee or a board of conferees and the session, instead of being called a recitation in English, was called a meeting of the board. At each of its sittings one of the students presided, and two or three members, acting as a subcommittee, presented a report to the board and advocated its adoption. This report generally consisted of some engineering project. For instance, at a typical session, the class was formed into a committee from a manufacturing company about to build a machine shop of a given size, and requiring a definite amount of power for lighting, heating and driving the machinery. Two members of the class, acting as engineers of a company dealing in power plant equipment and supplies, put before the board the advantages of the company owning its own power plant. Two other members of the class representing the local electric power company advocated that the board purchase central station power. After the presentation of each side, the class discussed the matter and finally voted upon the question. The presentation and discussion were made without notes, except for numerical data, etc. At the close of the discussion an instructor in English criticized the session, taking up such points as the work of the presiding officer, showing how he might have avoided some of the difficulties he encountered, and how he might have more easily extricated himself from those he did get into. The effectiveness of the presentation of the subject was taken up from the grammatical, literary, and psychological standpoints, the discussion of the class was commented upon from the point of view of its relevancy, and the vote of the class was criticised as to whether or not the class had really voted upon the merits of the question. A member of the engineering faculty usually discussed the whole subject from an engineering standpoint, generally as to whether or not a fair statement of the facts had been made. At the succeeding session of the class, a written report was always handed in to the English instructor by the men presenting the projects to the class and by the secretary of the board. During the first period at the works every man in the class had an opportunity to serve on two subcommittees, to preside over the meetings twice, and act as secretary twice.

During the second period at the works, the sessions in English took a different tack. On the previous occasion, emphasis had been placed on effective presentation of engineering projects in the interest of some company for which the student was supposed to be working. During this term's work the emphasis was laid upon the effective selling of one's own services or on interesting capital in one's own project. The instructor took the pains to explain the purpose of this term's work before asking the students to write. He showed them that each letter and each article that they wrote was written for the purpose of producing a certain effect and everything in the letter or article should add to this effect; that any piece of writing was effective only in so far as it produced the result that was desired. A letter written for the purpose of obtaining the writer a job, is effective if it lands the job. A prospectus written for the purpose of selling goods, is effective if it sells the goods. In keeping with this idea, the instructor put forward as the aim of this term's work, effectiveness in writing. Every bit of writing done that term was to have a definite purpose and be written to produce a certain effect.

Such exercises as these were used. "Write a description of a dusty room which will make the reader sneeze." "Write a letter asking for an appointment that will make the reader really desirous of seeing you." When the idea and aim of this course was understood, and the purpose of these themes explained, interesting writing competitions arose and work which formerly was looked upon as drudgery became an exciting contest. The class used as a textbook, examples of forceful writing contained in a volume of short articles by a well-known reporter.

I have dwelt at considerable length upon this first year's work in English because I am convinced of its importance to engineers. We still have two more years with this class in which to continue the work, and plans are being formulated to develop courses which will so appeal to the engineering student that he will put sufficient effort into the work to make it effective.

To go back to the differences between this coöperative course and others, I should like to mention as a fourth point the provision which is made for further liberalizing the engineering student's education by means of collateral reading. The plan which was adopted for housing the men lends itself very readily to the arrangements for this work. The students, while at Lynn, live together at the Thompson Club, a fine old residence which has been remodeled into a club house with private rooms for individual study, an assembly room for class work, a library, a billiard room, shower baths, etc. The club house forms a center of activities and here all class exercises are held. Advantage was taken of this arrangement to equip the library with a wide assortment of technical books from the institute library, and arrangements were made with the Lynn Public Library whereby several shelves are kept filled with books on all sorts of subjects and in many fields of literature. These books are exchanged from time to time for others suggested by members of the class and by the instructing staff. The sole aim of this part of the library is to make the appearance of the books so attractive and the subject matter so interesting and so accessible as to invite the men to use them. So important do we consider this side of the engineer's education that his program has been laid out with the definite purpose of giving him an opportunity for reading outside of the prescribed courses. We thoroughly believe in the desirability of creating the habit of general reading on the part of the engineer. This is in line with our conviction that if the men with engineering training can be induced to bring this training to bear on public questions and civic affairs, a great dynamic for good will be put into public life, a dynamic which has behind it all the power of a highly trained mind. The club library, together with the material used in the English course, affords only a beginning, but our efforts have met with gratifying results. At this early date there is evidence of an increased interest in public affairs and a growing appreciation of good literature.

The fifth point of difference which this course offers is the intense spirit of loyalty which has been inculcated in the members of this course; a loyalty to one another, to the institute and to the coöperating company. Several things have contributed to bring these conditions about. First, the closest connection has at all times been maintained between the institute and the group at the plant of the coöperating company. On three or four days each week a member of the electrical engineering department of the institute spends a half day at the plant visiting the various shops and offices to which the students are assigned, or to which they are to be assigned. In this way, as well as by the direct contact which is maintained in the two sessions a week in the class room, the student is made conscious of the supervision which the institute exercises over his work in the shop. To further decrease any sense of separation from the institute, there are always to be found on the library table copies of *The Tech* and *Technology Review,* two student publications of the institute, which help to keep the students at Lynn in close touch with the student life at Technology. Another feature which has not only kept the men closer to the institute, but has made a closer bond between the members of the two groups of coöperative students, has been the practice of having the group at the institute visit the Lynn their lectures on manufacturing methods. During good weather the department of electrical engineering furnished automobiles for the transportation of the men. The members of the group at Lynn were also encouraged to make frequent trips to the institute and to enter into the student activities there wherever it was possible. For instance, on "Tech Night" at a Boston theatre the group at the works attended in a body.

On other occasions, dinners were arranged at which one of the men acted as toastmaster and others were called upon for ten minute after dinner speeches. These dinners not only formed very pleasant occasions and knit the class closer together, but gave the students opportunity to try out the effectiveness of their English course. I know that the older men in the audience who have been bored nearly to death by after-dinner speeches will not very readily give their approval to this feature, but it must be remembered that young men get a good deal of enjoyment out of such affairs and these dinners were really welcomed as a pleasant break in the routine.

The fact that these students are all taking the same course at the same institution, and are working for the same coöperating company, and finally living together under the very pleasantest conditions, quickly develops this three-fold loyalty. It is this loyalty to the institute and to the company, founded upon the student's conviction that both the institute and the company are planning the work for his highest education and best welfare that in the last analysis must be depended upon to produce results in the way of conscientious and intelligent effort in delivering an honest day's work in the plant and in doing the full quota of study. Finally the coöperating company relies upon this loyalty to influence some of the men in each class to remain with the company after completing the course.

As the sixth point of difference in conducting this work should be mentioned the fact that throughout the three years students are kept in the plant of the same coöperating company. Under the right conditions we feel that this has its decided advantages, because once the officials of the company have determined upon such a policy as the General Electric Company have determined upon in connection with this course, this policy can be maintained and pursued in every department through which the students pass. Of course the company must be of such a size that it has all the departments in which an electrical engineer needs experience. We are fortunate in our coöperating company. It designs and manufactures electrical and mechanical machinery and apparatus of nearly every description and of the widest range of capacities, and many mechanical devices large and small, some of the most intricate design, the annual selling value of which exceeds two hunderd and fifty million dollars. Thus we are able to offer the student a wide choice in the departments in which he is to get his experience as well as in the particular branch he desires to specialize in. This arrangement has the advantage of offering the student the same diversity of work which a large number of smaller companies might offer him, without the disadvantage of a lack of coördination in details and in educational ideals.

The only remaining point of difference I wish to call to your attention is the unusual amount of theoretical work in the course and the fact that a Master's degree is awarded by the institute upon the completion of the five years' work. From the beginning of his freshman year to the end of his post-graduate year, the student pursues one course after another in mathematical physics. In the middle of his sophomore year he starts his work in the principles of electrical engineering and continues it without a break four terms a year for the remaining three and one half years of his course. During the last year the work at the institute is composed of advanced research and creative design, while at the works the student is given experience in the research laboratories of the company, or upon important work in the engineering and manufacturing offices. For a successful completion of this course the institution confers the degree of Master of Science, The degree of Bachelor of Science, conferred as of the year preceding the conferring of the Master's degree, is associated with the Master's degree. In this way the institute shows its appreciation of the value of advanced theoretical training combined with practical experience, which has been intelligently planned and carefully supervised.

In conclusion we should like to draw attention to the fact that this Course represents a constructive program in Electrical Engineering based upon sound principles of education. In the curriculum as above outlined it will be noted there have been included the following three fundamental elements which it has become recognized must be a part of the training of every modern engineer.

It includes eighteen months practical experience in the industry. Every engineer must sooner or later, obtain such experience before he can fill any responsible position.

It provides a greater amount of theoretical training than is usually given in a course in electrical engineering. The practical experience, therefore, is not gained at the expense of the theoretical instruction which, above everything else, it is the function of the school to provide.

It is enriched with a wealth of humanistic studies and experience in human engineering which it is believed is adequate to enable the young engineer early to take his rightful place among his fellow worker in the industry and among his fellow citizens in social activities.

REPORT OF THE CONFERENCE ON HIGHWAY AND HIGHWAY TRANSPORTATION ENGINEERING EDUCATION HELD IN WASHINGTON, MAY 14 AND 15, 1920.

BY ARTHUR H. BLANCHARD,

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The Conference on Highway Engineering and Highway Transportation Engineering held in Washington, D. C., on May 14 and 15, 1920, was called by the United States Commissioner of Education, Dr. P. P. Claxton. There were present 70 delegates representing the automotive and tire industries, transportation organizations, State highway departments, the Bureau of Public Roads, the War Department, and colleges of engineering. The educational secretary of the Conference was F. L. Bishop, dean of the school of engineering, University of Pittsburgh, and secretary of the S. P. E. E.

In his address of welcome, Commissioner Claxton stated that in recent years the rapidly changing industrial and economic needs of the country had created new and increasing demands for engineers. Additional types of engineers will be required to deal in a capable manner with the pressing problems of highway construction and of highway transportation which are daily becoming more and more acute.

Thomas H. McDonald, chief of the Bureau of Public Roads, Department of Agriculture, made it clear that the present demand for technically trained men is much greater than the capacity of our engineering schools is to prepare them. The highway program of this country has been greatly enlarged. In 1916, the total expenditures for roads were $272,634,413. For 1920, there is available for expenditure $783,000,000. The present indications are that the profession of highway engineering will, in the immediate future, offer adequate compensation to keep men from leaving it for other activities.

Roy D. Chapin, president of the Hudson Motor Car Company, said that the failure to foresee the demands for economical transportation has made it impossible for the railroads to meet the present situation. An unusual burden is being placed on the motor truck and this condition of affairs necessitates the training of thousands of men capable of handling the many problems of highway transportation. Last year, one billion tons of freight were hauled by the motor trucks of the country as against the 90,000,000 tons carried on the Great Lakes, and 2,504,000,000 tons moved by the railroads. The tremendous growth of motor transportation has outstripped our scientific knowledge just as it has outstripped our legal procedure. The necessary problems of research, which must be solved in order that the taxpayers' money may not be misused, should be the burden of our colleges. Broad courses in highway engineering and in highway transportation must be taught in a manner consonant with the importance of the issues involved.

Dr. Samuel P. Capen, Director of the American Council on Education, called attention to the comparatively recent development of scores of professional specialities in engineering schools. The training in these specialties tends to lag behind the professional demand. The trend in engineering education may be summarized as follows:

1. The primary task of the engineering schools is to teach the fundamental principles of engineering and its basic sciences.

2. Engineering schools will offer at the very end of the regular undergraduate courses or in post-graduate courses opportunities for specialization in one or more of the many branches of engineering.

3. These technical specialties which any individual school will cultivate will be determined in part by its location and in part by its facilities.

Dr. Walton C. John, of the Bureau of Education, stated that there are now 150 colleges and universities offering one or more courses in highway engineering. The colleges of engineering are working out the problems in highway engineering in four different ways: First, by means of the regular 4 year civil engineering curriculum leading to the degree of Bachelor of Science; second, by means of short, special and extension courses; third, by mutual coöperation between State or county highway departments in using the testing laboratories in the engineering colleges and engineering experiment stations; fourth, by means of graduate work and research in highway engineering problems. At least 12 universities and colleges of importance are given attention to the subject of highway transportation but especially in the filed pertaining to railroads. Highway transportation is now being taught as a distinct specialty in the University of Michigan, and a course has recently been offered in that subject at Oregon State College.

The Conference, at its last session, unanimously adopted sets of resolutions which were proposed by four committees, three of which had held public hearings on assigned subjects. In this brief report, only abstracted conclusions relative to proposed educational programs will be presented.

The Committee on Highway Engineering Education called attention to the following points:

The engineering staff needed for the control of highway construction will require an annual supply of 900 college trained civil engineers in addition to the highway engineers employed by counties and municipalities.

The civil engineering schools will graduate probably not more than 1,100 students three years from now. This quota is competed for by railroads, construction companies, and the industries, and by the county and municipal organizations. Probably not more than 300 would be normally available under the influences operating at present to fill this quota of 900.

In order that the colleges may provide facilities and a trained staff for instruction and research in highway engineering, more ample funds must be provided from private sources, from coöperative efforts with industries, and from taxation.

As a means of increasing the number of trained men available for the staff organizations of highway commissions, and the Federal Service, it is recommended that plans of coöperation be secured between the colleges and these organizations to provide for summer employment of students, which shall be related to the college instruction, and for further study by college graduates on the staff of the Commission, either through part time residence at the College, or by extension classes operated by the colleges with the assistance of the executives of the Commission.

The highway engineer deals with the public and with the broad issues of state and national affairs. He needs a training in the fundamentals as related to modern life. He must be an engineer trained to high technical standards, and in the methods of work of the scientist. Therefore, the subjects of English, economics, science, and business relations are important. Training in technique should be thorough and severe. Highway engineering subjects supply an excellent means of training in the several elements mentioned. A course in roads and pavements extending throughout one year is considered a fundamental subject in the civil engineering curriculum. A special optional course in the senior year presents a situation where the student is interested, becomes motivated, has intimate contact with the professor who is a competent practitioner as well as a teacher, and has an opportunity for library research and individual expression. Such specialization is highly educative and the ordinary objections to so-called specialization do not obtain.

The extent of unexplored fields of research in the design of pavements and in the properties of materials of construction as related to service conditions combined with necessity of throwing early light upon these problems, calls for a mobilization of all the resources of the testing laboratories in equipment, research teachers, and student workers, and for an appropriation of some portion of construction funds to provide support for this research.

The Committee on Highway Transportation Education presented the following statements as a preamble to its recommendation:

The phenomenal development of highway transportation in the United States has created a demand for men having knowledge of and training in a new technical field, which may be designated highway transport engineering, and which deals with the science, art, economics and business of transportation of passengers and commodities over highways.

The manufacturers and users of motor trucks have submitted the following estimates relative to the character and number of men required in the field of highway transport: first, that four thousand men should be trained in highway transport each year in universities for positions of motor truck fleet managers, sales engineers, advertisers, business administrators and highway transport engineers; second, that short period advanced courses efficiently provide opportunities for men occuplying the positions enumerated to obtain a knowledge and training in highway transport; third, that students in universities may be trained for the above mentioned positions through the medium of four year courses in highway transport engineering or group options in collegiate or technical courses.

The Committee presented the following conclusion, which was adopted: That this conference strongly recommends that universities and colleges offer courses in highway transport as their facilities will permit, and that at least ten universities, located in different geographical sections of the United States, offer short period advanced courses covering the various phases of highway transport, and four year courses in highway transport engineering or highway transport options in four year collegiate or technical courses.

The Committee on Business Education, and Highway and Technical Research submitted the following conclusions:

1. That research in highway engineering and highway

transportation problems is necessary to secure highways capable of carrying the traffic which will pass over them in the future.

2. That a moderate number of colleges and universities properly equipped and located in various sections of the country should be urged to undertake research in highway engineering and highway transportation, for the purpose of training undergraduates in the methods of research and solving the problems of highway engineering through competent graduate research.

3. That this research should be directed by some central authority, which should have power to call to its assistance other agencies and organizations capable of giving advice on this subject.

4. That sufficient funds should be raised and placed in charge of this central body to carry on this research.

5. That this central body should have power to invite the coöperation of State highway departments, of colleges and universities and experiment stations, and to assign to these coöperative agencies funds for the prosecution of this research and to supervise and direct the conduct of the work.

6. That in addition to these funds, the National Government be urged to appropriate generous funds for research in highway engineering and highway transportation, and that each state set aside a definite portion of the funds appropriated for highway construction for the prosecution of research in highway engineering and transportation.

7. That the State highway departments should, wherever possible, seek the coöperation of colleges and universities and experiment stations in solving research problems in highway engineering peculiar to the State concerned.

Pertaining to business education, the Committee recommended:

That the conference endorses the idea of a liberal opportunity for engineering students to take courses in business education which will train them for managerial positions in the industries.

That the conference favors the establishment of schools of business and commerce in which students, in addition to numerous courses in business and commercial economics, may secure such technical and general training as will fit them for leadership in the industries.

That the colleges of arts and sciences encourage the placing of courses in business economics on a par with the humanities, in order that graduates of these colleges may take their place in industries speedily and intelligently.

The General Committee on Resolutions particularly emphasized the following statements:

That there is no one domestic activity of more vital import to the people of the United States than an efficient and economical administration of our highway program.

That there is a pressing demand for trained men not alone to guide this program but also to undertake the problems of production and the economic use of vehicles over the highway.

That this need can only be met by increased educational facilities for turning out these men.

That the entire subject is one which should be closely coördinated and a permanent committee should be appointed by the Commissioner of Education to consider this problem in its several aspects and to bring about a fuller understanding of it on the part of the people of the country.

RESOLUTION OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

J. F. Hayford: Mr. President, the key note of this meeting being coöperation, it is surely perfectly in order to deliver to you an offer of coöperation from an outside organization. The formal statement of the offer is written here on a slip of paper which will be left posted to be examined by you at leisure later. What I propose to do in five minutes, is to simply read that notice, and then give you a few words of explanation that may be necessary.

The notice itself reads:

"At its meeting of April 22nd, 1920, The National Advisory Committee for Aeronautics, passed the following resolution:

"*Resolved,* that the Executive Committee be instructed to undertake, insofar as may be found practicable, the coöperation of air-dynamic research work in the educational institutions of the country where are located air-dynamic laboratories, to the end that greate general efficiency in carrying out such work among the scattered research units may be realized, unnecessary duplication of effort avoided, and in order that the work in these various research laboratories may be carried forward together with similar working of the government laboratories, as intelligently related parts of a general research program."

"Any correspondence in regard to this matter should be addressed to the Chairman of the Executive Committee, National Advisory Committee for Aeronautics, 2722 Navy Building, 17th and B Streets, Washington, D. C."

The chairman referred to is Professor J. F. Ames, of the Department of Physics of Johns Hopkins University. It is at his request that I am putting this offer of coöperation before you. That is, it is genuinely an offer on the part of the National Advisory Committee for Aëronautics to coöperate with you, if you are thinking of doing any research work in aëro-dynamics in your own laboratories. Just a word of explanation which may be needed for some of you, at least, as to what the National Advisory Committee for Aëronautics is. Though it functioned throughout the war as one of the various agencies doing what it could in the war work, it is pre-war committee, established in 1915, a committee which is continuing its work on an appropriation of about $200,000 a year. I happen to have been on the Committee since the beginning. That is how it happened I have been able to deliver this message to you today.

In the words of the law, the main duty of the committee is to supervise and direct the scientific study of the problems of flight with a view to their practical solution. We have in our regular work had some coöperation with university research laboratories, the biggest piece of coöperation being with the laboratory of Stanford University, under Prof. W. F. Durand, in which a very extensive work was done on propellors for use in air.

This is not an offer to help by restriction. There is much more research work in aero-dynamics that is urgently needed than can be done by all the government agencies combined, and all the other agencies that can be prevailed upon to undertake the work. What is wanted is more work, and more effective work. So this is an offer to help in bringing about coöperation, helping you perhaps to see the vision and so get you to do some of the needed things, if you will. There is no disposition to put the emphasis very strongly on avoiding duplication. There is a disposition to put the emphasis very strongly on getting you to work as you choose in that general line.

Now, this notice will remain up here so that if any of you wish to get the exact address or find out more about this, you may do so, and I will be glad to explain further at any time you care to have further explanation. Thank you.

REPORT OF INSTITUTIONAL COMMITTEE NO. 7.

The Institutional Committee of the S. P. E. E. carried out the wishes of the Society in connection with the organization of sections. The object of the sections is the same as that of the Parent Society, but particular emphasis is placed upon educational problems confronting the particular locality which the section serves.

Since the Baltimore Meeting of the S. P. E. E. the following Sections of the Society were organized.

1. The Pittsburgh Section,
2. The Atlanta Georgia Section,
3. The Kansas-Nebraska Section.

Progress was also made toward the organization of a New England Section, a Northwestern Section (including Oregon, Washington and Idaho) a Southwestern Section (including Arizona and New Mexico) and a section at the St. John's College, China.

Most institutions look favorably upon the idea of organizing sections of the Society in their localities. The general conditions of unrest among teachers and the heavy teaching schedules on account of large enrollment makes at present the organization of new activities very difficult.

The Institutional Delegates at their conference in connection with the Ann Arbor meeting of the Society on Wednesday, June 30th, voted to continue the organization of Sections of the S. P. E. E. wherever possible.

The Institutional delegates also voted to recommend to the Society that a Committee of the Society be appointed to investigate the Present Status of the Special Apprenticeship Systems established by railroads.

The Institutional Committee also recommends that in future meetings more time be set aside for the conferences of institutional delegates. The present plan of allowing one half hour for such conferences is absolutely inadequate.

A. A. Potter,
Chairman, Institutional Committee.

REPORT OF COMMITTEE (10) MATHEMATICS,

L. C. Plant: Mr. President, committee No. 10 has no report to make at this time. I wish to make a few remarks, however. Previous to our entering into the World War Committee No. 10 made quite an extensive study of the coördination of mathematics, physics and mechanics, and reported its findings to the society. It was hoped at that time that a number of institutions would take up the matter of coördination of these subjects, and allied subjects, and make reports to the Society at subsequent meetings. Due to our engaging in the war and a general neglect in a way of our school problems, we have not heard any reports from any of the institutions since that time.

At this time, however, we are to have the pleasure of hearing a report of Prof. Coddington, of the Ohio State University, and also a report on the study of Engineering problems by Mr. Kiefer, from Iowa State.

REPORT OF THE COMMITTEE NO. 11-A, PHYSICS.

The work of the Committee of Physics has reached a stage where a review of its endeavors should be given and a recommendation made to the Society for future action. The present Committee was appointed in 1916. It found that its predecessor had presented an excellent report which contained the results of a survey of the courses in physics in the various engineering colleges and certain important recommendations. Your Committee proceeded to ascertain in what direction the greatest assistance could be rendered to instruction in physics and it decided that correlation of the course in physics with subsequent courses using the fundamental principles of physics would be the most valuable contribution the committee could make in the work of the Society.

On March 15, 1917, the Committee on Mechanics, through its chairman, Professor E. R. Maurer, agreed to a joint effort in coöperation which may be described as the "preparation of a syllabus on mechanics" as a highly "desirable method of influencing the coöperation which should exist between the two courses in mechanics." The Committee on Physics was to prepare the physics portion of the syllabus and the Committee on Mechanics was to prepare the material for the course in mechanics. The order of presentation of the topics of the syllabus was to be merely that of convenience, emphasis being placed on subject matter rather than upon order of presentation.

The Committee on Physics prepared its portion of the syllabus which was submitted to the Committee on Mechanics on December 6, 1917. The form of the "Content" was an alphabetical list of subject matter, with all formulæ, units and even the nature of the problems, the latter appearing each one in its appropriate place. Suitable cross references were made, so that it was possible to ascertain quickly just what was supposed to be taught in the first general course in physics on the subject of mechanics. The effort of the Committee was to be brief, to be concrete and specific, to avoid "methods of presentation" and the arguments resulting therefrom and to furnish a clear picture of what should be expected of the first course in physics. In the relatively brief time between December, 1917, and June, 1918, no report was made by the Committee on Mechanics to the Committee on Physics as to the progress of the proposed syllabus.

On December 19, 1918, the Committee on Physics resubmitted the "Content" to the new Committee on Mechanics and Hydraulics, recently appointed. The latter Comittee considered the original proposal and reported back to the Committee on Physics on May 19, 1919, that the Committee on Mechanics and Hydraulics seemed to be in favor of coöperation. No further report was had from this Committee until the chairman of the Committee on Physics requested a conference with the Chairman of the other Committee. Then the latter consulted with a member of his Committee and several others and formulated a tentative report indicating that the coöperation as proposed was inappropriate. But later, on May 3 and 4, the chairman of the two committees had an extended conference which very naturally brought about a better understanding as to what the Committee on Physics hoped to accomplish by its plan of coöperative effort. The chairman of the Committee on Mechanics and Hydraulics, Professor O. H. Basquin, was not convinced that the exact plan proposed by the Committee on Physics was the best to be had. No future plans were laid as to a joint action of the two committees because of the short time remaining before the annual meeting.

The Committee on Physics wishes to present to the Society briefly its defense of the plan of coöperation described and the possibilities of correlation arising from its application. The basis of the argument presented briefly, and hence inadequately, is as follows:

1. All efforts at coöperation must have as a basis relevant facts; this is the starting point of all endeavor in which the scientific method is used.

2. The most important information that should be available as a basis of coöperation in and consequent correlation of the two courses of mechanics, is the *content* of the two courses.

3. Such information should be in reference form. This could be accomplished by the completion of the alphabetical topic list described above, the "content" of the mechanics course being placed perhaps in a parallel column with the content in the physics course. This would make the information desired available with a minimum expenditure of time.

4. From such information immediately would arise definite possibilities of correlation as illustrated by the following attainments:

(*a*) The securing of more appropriate emphasis in the physics course.

(*b*) The saving of time and improvement of results in the mechanics course through the utilization of review as such. Other possibilities will occur at once to a teacher in either course.

The chief arguments against the form of coöperative effort proposed are as follows:

1. Instructors in mechanics and physics are fairly well satisfied with conditions as they are. The reply is that it is not the satisfaction of the instructor in which the Committee should be interested, but the fact that the student takes two succeeding courses in the same subject between which no effort at correlation has been made by the Society.

2. Coöperation can be had in any institution where the instructors desire it and such a plan as proposed is not necessary. The answer is that the Committees' work is that of the Society, that, truly, the Society is not necessary, but that each

Committee should endeavor to make the Society as effective as possible in improving engineering education.

3. Instead of the proposed plan it may be better to formulate a general plan and let each institution carry it out as suits individual preference. The answer is that the Committee on Physics does not favor advice, but rather a constructive piece of work of a concrete character, believing that this is a kind of a contribution that the Society should make.

In this connection, your Committee calls attention to the fact that at the Virginia meeting in 1916, it was moved by Professor Greene, seconded and carried, that "It is the sense of this meeting that the Committee on Mechanics in the preparation of its syllabus hold conferences either by letter or at meetings with the Committee on the Teaching of Physics."

A further word in reference to correlation might make clearer its meaning and its need. Correlation between courses articulates instruction by eliminating gaps and inconsistencies between them. It makes the work more interesting to the student and it tends to economy in his time. It enables an instructor to do better work; it gives him definite information regarding the previous intellectual attainments of his students, and it shows him what they will be called upon to do in future courses. He is able, therefore, to give them instruction that is adapted to their preparation, and to the demands of other instructors. He is able to review old material as such and thus greatly aid its retention by the student.

Moreover, the instructors in any one department develop departmental ideals and traditions, and methods of teaching and establish the ground covered largely independent of other departments; they feel pride in their own department; they concentrate upon their own work; they think they have not time to understand the points of view of other departments. A feeling of mutual distrust naturally arises and some degree of isolation ensues; isolation is the opposite of correlation.

Your Committee wishes to express the opinion, based upon the thought given the matter and upon its experience in working with another Committee, that the correlation of the course in physics with subsequent courses in which the fundamentals of physics are used is highly important; that the Society should appoint a Special Committee for the purpose of making a report upon the subject; that this report should describe the desired correlation in mechanics in such a manner that the report can be applied directly without requiring each institution to work out, ab initio, its own plan, that the report should be concrete in at least one subject, mechanics, and that it include a statement of the practicable ways and means of securing correlation in other subjects as well.

Your Committee therefore recommends that the Society authorize the appointment of a Special Committee whose duty shall be to make a report upon the correlation of the course in physics with subsequent engineering courses, particularly that in mechanics.

REPORT OF COMMITTEE 11-B, CHEMISTRY.

Your committee has conferred with the Committee on Educational Problems of the American Chemical Society. It desires to discuss briefly several subjects which deserve consideration, viz.:

1. The courses which should be taken by candidates for undergraduate degrees for which Chemistry is the major subject, and the minimum time which should be devoted to each course.
2. Courses in Industrial Chemistry and vocational courses.
3. A fifth year in residence and the character of the work of this year.
4. Difficulties in the way of intercollegiate transfer from many smaller institutions, and suggestions for their correction.
5. Aids to training in research methods.
6. The future supply of chemists.

1. *Required Courses.*—We recommend that the following courses in chemistry be required for undergraduate degrees for which chemistry is the major subject, the total time shown to be the approximate minimum—varied between class and laboratory as seems wise.

(*a*) *General Chemistry,* including some Qualitative Analysis. Class, 3 hrs.; Lab'y, 6 hrs. per week for 32 weeks, not including examination periods. First year.

(*b*) *Qualitative* and *Quantitative Analysis.* Same as (*a*) above. Second year.

(*c*) *Quantitative Analysis,* Class and Laboratory, 12 hrs. a week for 32 weeks. Third year.

(*d*) *Organic Chemistry.* Same as (*a*) above. Second or Third year.

(*e*) *Physical Chemistry.* Same as (*a*) above. Fourth year.*

(*f*) .*Industrial Chemistry,* class and laboratory work, 12 or more hours a week, for 32 weeks. (See paragraph 2.) Fourth year.

2. *Courses in Industrial Chemistry.*—In the opinion of your committee, much of the time so frequently spent upon the *processes* given in the textbooks of General Industrial Chemistry may be better employed in a course which emphasizes the general chemical, engineering and economic *problems and their solutions,* and which deals with the surmounting of the difficulties encountered in as many of the industries as the time will permit. Very little attempt should be made to deal with the technical details of any process. This will orientate the mind of the student so that he can apply himself more easily and use his chemistry, physics and engineering more effectively when he goes into an industry of any kind. Proper orientation can not be accomplished by any other means than the correct teaching of Industrial Chemistry. This must be given by a good teacher who is thoroughly grounded in the fundamentals and who must have himself had the responsibility of handling manufacturing problems and processes.

Parallel reading of current industrial-chemical journals should be insisted upon, and reports upon selected articles should be made by students to the class.

The special study of any one line should be left to "Vocational Studies" that are taken up as separate subjects.

An industry may be handicapped through a lack of ideas regarding its possibilities for new or improved processes, or a lack of knowledge or sources of information which will permit work looking towards their realization. Hence, the instruction and reading of the student should direct his attention to lines of possible development and give him a very thorough understanding of all matters that are necessary to progressive activities.

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* If an adjustment of the work can be made which will permit a beginning of the course in Physical Chemistry during the last half of the third year, it will improve the work of the senior year.

3. *A Fifth Year in Residence.*—It is becoming more and more generally recognized that the amount of time necessary to fit a man fully for entering any branch of engineering can not be crowded into four years; that is, if the student is to have time to digest what he learns, to learn through laboratory work how the various problems are attacked and how the data of the research laboratory is translated into practice.

We believe that the solution of this lies best in a fifth or graduate year of directed study; and that most of the time of this year should be spent on an intensive study of methods of chemical research. This work should give the student a very real insight into how chemical knowledge is acquired and applied to production. He should learn how to use the library in research work. His laboratory work may well be around some industrial problem in that branch of the science in which he thinks of specializing, but his instruction in general methods of research should be as full as conditions permit. He might also take a course in a cognate science, if this does not distract his attention too much. The work of this fifth year might lead to the Masters degree, or its equivalent, or prepare for more advanced work leading to the Doctor's degree, or it may more fully and directly prepare for high grade work in the industrial field than it is possible to do during four undergraduate years.

During this fifth year the student should, of course, go to an institution where the highest grade of research work is being conducted in the particular field that he contemplates entering. No mere sentiment or financial consideration should induce him to stay at his undergraduate college unless it is fully equipped both as regards men and facilities; and even then it may be well to move.

Much attention is being given to a close correlation between educational and industrial institutions. The more that is accomplished along this line the more effective will be the work at both places.

4. *Difficulties in the Way of Intercollegiate Transfer from Smaller Institutions, and Suggestions for their Correction.*—The best possible teaching might be done in smaller institutions where a personal contact between professor and student obtains to a degree that is not possible in places where the numbers are so large that much of the instruction in quiz-class and laboratory must needs be left to less experienced assistants. Those of us who come into contact for graduate study with men from the smaller colleges find that the training in the fundamentals of far too many of such has been very poor. We have searched for the cause of this condition. We believe that *the trouble arises largely through too many courses being given for the size of the teaching staff.* The teachers' time and energy are consumed by many courses to which too little time or thought is devoted, instead of being used to give a few thorough ones. One example will illustrate the condition which obtains to a greater or lesser degree at many places. At a school of technology, in a community offering the largest possibilities for real service, four teachers are conducting several classes, in several branches, aggregating over 500 students. They are compelled by somebody to teach twenty-seven or more hours a week, not including all the additional time incident to chemical instruction. Their class in General Chemistry meets four times a week for class, and works two hours (actual time) in the laboratory. Equally insufficient time is devoted to other courses. We understand that this is done under protest and that the faculty realize the shortcomings.

The final result of such totally inadequate training is a "chemical engineer" who honestly thinks that he knows some chemistry—until he runs up against the real work of the world. Another graduate wishes to enter a reputable medical school—they will not admit him. Another has taken all the chemistry in sight and wishes to begin graduate work in a good university—they will not permit him to do so without considerably more training; or he tries it and fails. *If the same time which is devoted to many courses were spent upon General Chemistry and one other, by both teachers and students, the results would be worth while.*

5. *Aids to Training in Research.*—Specialized instruction should be developed in universities whose environment permits of a close correlation with particular industries. There should be at least one university whose staff and equipment is adequate to the highest possible research training in each of the great lines of industry: institutions to which we might direct young men who are equipped and desire such training.

More research work must be done at many of the smaller institutions than now, *if their teaching staffs are to continue fit to train even undergraduates for the industrial world.* A teacher whose whole time is consumed with routine undergraduate instruction will inevitably cease to grow and he will quickly get out of touch with everything but textbook matter. He will become, for practical purposes, almost entirely out of touch with the development of new methods and new knowledge, and after a while will be unfit to do such research work as will help his institution to rise to its highest possibilities and keep pace with a growing community.

Concrete proof that all too many teachers have already arrived perilously near to this condition of unfitness, through overwork in routine teaching, may be obtained if an assistant or bright student will ask his professor for "some research problem that I may work upon." How many of such unfortunate professors are able to name even two or three suitable problems—worth-while problems which are suited to the capacity of even a senior or a fifth-year student? Do they really know in sufficient detail many of the gaps in our knowledge; what new methods of attack might solve old problems; where the problems they have thought of, more or less casually, are likely to lead; whether or not these have been worked upon and by whom; etc.? How few of the smaller colleges have adequate equipment and library facilities for such research study as will make their professors more efficient undergraduate teachers? Many good men have gone steadily downward under the pressure of too much routine work, too few facilities, and a salary too small to permit of their getting out into the world, meeting their fellow professional men and getting new incentives to work. The younger men are leaving the field in large numbers; the older men have given hostages to fortune and must stay, but their days are numbered.

We believe that many men will be reinvigorated and all will be helped if some institution like the National Research Council will collect from the larger universities and from the industries a number of problems which teachers at the smaller institutions may work upon and assign to their assistants and senior students. The by-problems of the industrial laboratories will constitute a large and most interesting supply. Arrangements might be made for the loan of suitable apparatus. Books and periodicals can be easily obtained. Results of such work might be turned over to others to check, where necessary. More coöperative work can be done in this way, which will gradually fill in the gaps, accumulate needed data regarding substances, bring men together with benefit to both, and, above all, start many men to doing research study if they have dropped out, and prevent many from discontinuing investigations after they leave the universities. Your committee has recommended this plan to the National Research Council as one means of promoting advanced study by teachers, who are more likely to continue if they once get started and have available a constant supply of live problems, and as a help towards inciting a research spirit in senior students. The reception of the suggestion by the Council is encouraging.

6. *The Future Supply of Chemists.*—Prior to 1914 the relative numbers of industrial chemists in each of the various countries was in the same order as the industrial positions of such

countries. The war fully demonstrated to America the importance of the chemist, in addition to the engineer. The rapid growth of the industries and the more general employment of chemists has brought about a most serious situation as regards the future supply of well trained men to meet the growing demands. The higher salaries offered in the business world has drawn large numbers of men from the teaching profession, especially the high-grade younger men. This is partly because the salary increases in educational institutions have in no wise kept pace with the increasing cost of the necessities of life for educated men; and partly because the increased burden imposed by larger numbers of students and the increasing difficulty in finding competent young men as assistants has greatly lessened the attractiveness of the teaching profession. Under such a state of affairs less time can be devoted to work which makes for professional growth or necessary additional income.

Something must be done to increase the number of strong, well trained, men in the teaching field, *or we shall soon have the training done largely by weak men who are not leaders in the profession.* Poor teachers cannot possibly train such men as are needed to enable America to take her natural place among the great industrial nations. All will suffer and matters will grow worse with the passage of time. All this is only too well recognized by the profession. The authorities of educational institutions must also be brought to so thorough a realization of the need that they will correct it. Additional money should be got by an increase in the cost of education to the student, if it can not be obtained in other ways. Why should not the individual or the state pay the full, natural cost of developing the most efficient mental power in like manner as they pay for motive power? The unsubstantiated objection that higher cost will mean fewer college students is met by the fact that fewer well trained men are of greater value to the nation than many poorly trained men. The poorly trained man is not apt to grow afterwards, and he becomes a source of danger, both economically and politically.

Respectfully submitted,
JAMES R. WITHROW,
J. H. JAMES,
R. M. BIRD, *Chairman.*

Affiliated with the Committee on Educational Problems of the American Chemical Society.

RALPH H. McKEE,
S. W. PARR,
LAUDER W. JONES, *Chairman.*

June 1, 1920.

REPORT OF COMMITTEE NO. 12, ENGLISH.

In 1915, under the direction of the late Professor Samuel C. Earle, an investigation was made by Committee No. 12 to determine the status of instruction in English in engineering colleges. The principal questions raised in this inquiry dealt with educational policy affecting the purpose of the course in English, the kind of instruction given, and the position of the teacher of English among his technical colleagues. The usual questionnaire was supplemented by a tour of inspection made by Professor Earle. Although the findings of the Committee were largely negative, it may be worth while to recall them briefly for the sake of comparison, or rather, contrast, with the present.

In the great majority of engineering colleges it appeared that little or no attention had been given to the reason for having instruction in English. The course in English was a tradition, like gymnasium and military drill; and, administratively considered, it was not less remote or incidental than these two subjects. To be sure, this criticism applied equally to the Liberal Arts Colleges and to all other departments in which the standardized requirements for freshman English were in force. The noteworthy difference in the engineering colleges arose from the fact that English appeared to be a stray subject. The technical studies formed a fairly close-knit group, each with its particular function and its relation to the whole purpose of the curriculum. As for English, it was sufficient for the technical instructors to allow it three hours a week in the schedule for the freshman year and then to forget its existence. All too frequently, the instructor in English paralleled this attitude by thinking it enough that he give the students three hours a week of something, anything, and then forget about *their* existence. The students were even more willing to forget, once they had canceled the requirements imposed by tradition. This situation was frankly admitted by all parties to the arrangement, and, except for a different procedure in a dozen or so institutions, it may almost be called typical.

Granted the original assumption, that English for engineering students is a threefold nuisance, to be abated as soon as possible, it was perfectly logical that it should be dismissed from everybody's consciousness in the comparatively painless manner just indicated. Naturally, this view of the matter precluded any profitable response to the Committee's inquiry. Nobody troubled himself about the purpose of English or the kind of instruction. The teacher of English was not, strictly speaking, a member of the engineering faculty. By common consent, he remained at a safe distance from the scene of purposeful instruction.

It would be unfair to omit passing reference to the exceptions. In several engineering colleges, notably Tufts, Delaware, Massachusetts Institute of Technology, Case, Iowa State College, the University of Cincinnati, and the state universities of Kansas, Virginia, Wisconsin, Michigan, and Illinois, a different attitude was reported. In some of these schools, the initiative had come from the technical, in others, from the English, department, but the result was the same in either case. Wherever the two had joined in an effort to solve their common problem, the course in English had become more interesting and more effective.

Soon after this investigation was made, there began what may be called a period of "academic introspection"—an era which continues to the present. The constant pressure for the addition of new subjects to the curriculum called for an examination of those already included, to determine their relative importance. The frank criticism of engineering graduates by business and professional men gave impetus to this movement. As Dr. Mann has pointed out in his report, the need for a broader training was evident, if the colleges were to supply the type of engineer demanded by modern conditions.

Since English had been so generally treated as a mere traditional appendage to the engineering curriculum, any analysis which the various colleges made of the course of study was likely to benefit the English department. Even if the subject were dropped, its omission would hardly be worse than its continuance on a basis of traditional perfunctoriness or indifference. As a matter of fact, in many colleges English has been given a more favorable status. Its function has been more clearly defined, and for this reason, even where the general outlines of the course have remained unchanged, the spirit of the instruction has been improved. The amount of time given to English either has remained the same or has been increased. Expansion of the work of the English department has come in two ways: first, by the addition of new courses in such subjects as journalism, report writing, argumentation, general literature, technical literature, and public speaking; secondly, in the inclusion with English of certain other humanistic or cultural subjects, such as current issues, history, logic, and political economy. The second development, which our present investigation shows to be limited in extent, may perhaps be regarded as a tribute to the English teacher's versatility, or at least, to the range of his department. It is more significant, of course, as an indication of the recent broadening and humanizing of the course in engineering, and should be considered along with the inclusion of other non-technical subjects which have primarily cultural or humanizing value.

The instructor in English, even though he may not be called upon to teach non-technical subjects outside his own field, is interested in the student's background. For this reason, and also because the matter seemed not to fall within the scope of any other committee of the Society, Committee No. 12 decided to include in this year's investigation a survey of required and elective non-technical courses. It was believed that information regarding this matter would be of interest to all members of the Society who are concerned with the engineering curriculum. Accordingly, certain data were collected, and expressions of attitude and policy were requested from deans and professors in the various institutions represented in the Society's membership. Some of these expressions of opinion and policy are found in the May issue of *Engineering Education.* The attitude indicated by the quotations in this preliminary report is typical of all who have responded. Although preferences differ as to the particular studies to be given, their place in the schedule, or the manner of teaching them, there is complete unanimity regarding the desirability of instruction in humanistic subjects. In truth, the only limiting factor generally recognized is the irreducible minimum of instruction in the fundamental technical studies during four years of college work.

Statistics are now being compiled which, it is believed, will give a fairly comprehensive view of the instruction now given in English and in other non-technical subjects which are more or less nearly related to it. The committee will ask leave to print during the year a tabulated digest of information received from the various institutions coöperating with us in this investigation. This includes practically all the schools of engineering. (Parenthetically, I wish to comment upon the cordial spirit shown by deans and others in responding to the committee's inquiries. I hope that until we can acknowledge their contributions directly to the individuals, this general statement of appreciation will be accepted in lieu of special mention.)

Although the data promised have not all been received, sufficient material is at hand to indicate pretty clearly the status of the engineering curriculum at present. It is hardly likely that the percentages will be materially affected by the remaining institutions which will be included in the committee's published report.

Of 58 engineering colleges from which the committee has so far received data, all but four (93 per cent.) require the standard freshman course in English composition. Three of these four exceptions, however, require its equivalent for entrance. The other one plans to introduce instruction in English composition next year, and a committee of the faculty is working out a program to this end. Thirty-seven (64 per cent.) of the 58 require an advanced course in English composition, consisting of report writing, technical journalism, public speaking, or argumentation, especially designed for engineering students. Forty-four (76 per cent.) require non-technical studies other than English composition and modern languages. Of these non-technical subjects, the most popular is economics, required in 33 institutions (57 per cent.). Literature is a close second, being required in 30 (52 per cent.) of the colleges reporting. History comes next, with 16 schools (28 per cent.) requiring it for the engineering degree. The other required subjects listed, with the respective number of colleges requiring them are as follows: Political Science, 3; Logic, 2; Psychology, 1; Philosophy, 1; Bible, 1.

C. M. Park, *Chairman,*
University of Cincinnati.

THE QUALIFICATIONS OF THE TEACHER OF ENGLISH FOR ENGINEERING STUDENTS.

BY S. A. HARBARGER,

Department of English, Ohio State University.

After satisfactory compromises have been effected concerning the course of study that will best train the engineering student for his profession, there is still the necessity of making a careful study of the individual traits of this student, and those of the teacher who is to train him in the fundamentals of engineering, and in the business, ethical and cultural standards that belong peculiarly to engineering as a profession. Colleges and universities can serve better and coöperate more fully than they now do with the concerns into which their graduates are likely to go, if they will make the conscious effort to know definitely and guage accurately the ability and the professional and personal character of their undergraduates and of their academic leaders.

It is not the purpose of this discussion to consider the qualifications or specifications for leadership that are essential to the teacher of engineering fundamentals. There are, doubtless, specific demands that ought to have separate study. One thing is, however, probably true. The students do not so frequently come to mathematics and chemistry with such apparent dislike or with such violent and positive antagonism as they do to English, which, from their previous study of it, seems to them quite unrelated to their future profession. The teacher of English, therefore, is immediately compelled to make plain the relationship between English and engineering in order to secure the tolerance and the coöperation of the engineering student.

The experience of the most successful teachers of English for engineering students seems to have demonstrated very clearly and convincingly that the college course in this subject should start with the students' interest in engineering and should make plain to them that they need English (1) to amplify, reinforce, make clear, and extend the range of the ideas expressed through blue prints, and mathematical symbols and formulas; (2) to become articulate for the purpose of rendering through their profession, effective and constructive service to the world; (3) to be able, because of a similarity of cultural background, to take their rightful place among men of other professions as progressive leaders in their communities.

A course with this extended yet graduated aim seems to accomplish the best results because it takes into account the fact that the engineering student has some very pronounced and easily discernible characteristics. First of all, at the very outset of his college course, he is unusually definite as compared with students registered in other colleges. Next, he is very practical. That is, he wants his college work associated with reality; he insists upon tangible results from all of his efforts. Then, he is eager and enthusiastic about his work and extremely impatient with anything that retards his progress. Some of this eagerness and this enthusiasm are, of course, indicative of his youthfulness—the source also of his first intolerance of cultural subjects, and his lack of appreciation of relative values. But under a sympathetic and well balanced instructor, this eagerness and this enthusiasm can be restrained, directed, and invested by the student so that they become great factors for success in his maturity. They are the qualities that preserve his idealism and keep his faith alive in spite of loss, disappointment, failure, and disillusionment.

These pronounced characteristics of the engineering student-definiteness, practicality, eagerness, enthusiasm and youthfulness—have a direct bearing upon the English teacher. His own characteristics must be supplementary and even similar if he is to recognize and capitalize these traits in his students, and to give orientation, reach, direction, restraint, balance and power to those who come under his influence.

With the idea of discovering, at least a few definite qualifications of a teacher of English for this student with very distinct characteristics, and with a very clearcut aim in mind, your Committee in its questionnaire, included one heading on qualifications. To these suggestions from deans of various colleges of engineering in the United States and Canada and from interested instructors in English—heads of departments and special teachers—the writer has added twelve years' observation and teaching experience; discussion on every opportune occasion within that time on the subject of English for engineering students with thoughtful undergraduates, practicing engineers, prominent members of engineering college faculties of several well known educational institutions; careful reading and study of the technical press. What follows, therefore, represents the pooling of the opinions from these several sources.

All would probably agree that there are certain necessary characteristics of English teachers that are common to every one, irrespective of what type of student comes under his leadership. These qualities are accurate professional knowledge, successful experience, liveness, insight, balance, judgment, sympathy, breadth, tolerance, culture, and character. As outgrowths of these, and as extended developments of them perhaps, are certain distinctive traits as pronounced and as noticeable in the English teacher for engineering students as those who follow his instruction. These traits are worth extended study, for they are vital to his success and to that of the college of engineering.

First of all, the teacher of English must have an appreciation of the engineer's use for language. He must realize that the engineer needs English as a tool—an accurate, well designed, powerful tool, capable of a variety of uses that will bring the engineer financial returns and advance his professional prestige. The good English teacher is free from the "culture obscession." Though he may, before the course is completed, lead out into some of the cultural aspects of English by subtle references and appropriate comparisons, yet he never loses sight of the fact that engineers need English as a tool. He associates English, therefore, with reality and finds an objective for his students' thoughts, as they express them in speech and in writing, that is within their range and that leads toward their goal. He attempts to guide constructively their imaginations. Through system, clearness, and accuracy to a fine, honest sense of proportion and relative values, and independent thinking. He trains for remorseless and scientific efficiency in the use of words for the purpose of getting tangible results. He makes the connection of English with engineering apparent.

Though some few seem to think that the teacher of English should have an engineering degree, most do not consider such specialization necessary. But the instructor in English most unquestionably have an interest in science and some engineering aptitude whereby he will intuitively understand and sympathize with the problems and ambitions of his students. He must be sincerely interested in the whole aim and trend of engineering education; respect, admire, and be a good listener and get men to talk enthusiastically of their work. He must have enough knowledge of the hardships and the difficulties that are encountered in an engineering undertaking to appreciate the cost not only in dollars and cents but in energy and spirit, and to understand the justifiable glow of elation and the feeling of victory that every engineer has when his work is complete, safe and useful. A teacher of English who has this insight, knowledge, and sympathy has an engineering aptitude; he can give breadth of vision to those who are taking up engineering as a profession. He has a knowledge of the distinctive features of the various branches of engineering and can impart, through his own inherent interest and sincerity of feeling, a spirit that will tend to make his students plod on willingly in the daily routine.

A third special qualification is that the English instructor must be able to write articles that are acceptable to technical journals and magazines. Definite results of theory wherever they appear always impress engineering students. If in their perusal of technical periodicals—for every good teacher of English will turn the attention of his students early to the current literature of his profession—they come upon articles written by the English instructor, the stock of English and of the instructor rises. If, in addition, the English teacher accepts opportunities to write articles for student technical publications, he can gain much prestige through this connection with the activities of the technical students, and is also less of an outsider. In both cases, the English instructor has a splendid chance to demonstrate that he can practice what he preaches. For he pays particular attention to organization, display, clearness, conciseness, and emphasis. Incidentally, this actual writing keeps the instructor from being too theoretical and from expecting too much from immature, unskilled and inexperienced writers. It makes his teaching live and convincing; it gives him an incentive for keeping fit. It takes remorseless and scientific efficiency in the use of words to practice what one preaches in an English class composed of engineering students. Yet it is a valuable demonstration of complete and satisfactory assembling of material to produce the desired result. It is the kind of practical demonstration that wins the engineering student and secures his sincere and hearty coöperation.

A fourth peculiar asset of the teacher of English for technical students is a wide acquaintance with practicing engineers through their writings and through natural personal friendships. This acquaintanceship is absolutely necessary if the instructor is to keep his teaching rich, full, forward-looking, and convincing. He learns from both sources the tendencies of modern engineering thought, the present day problems and projects, the increasing range of influence of the engineering profession, the character of the leaders, the sincerity of their leadership, their breadth of vision, and their conception of the human relationships. He talks, he listens, he reads, he adventures under their guidance and receives their interpretation of ''utilizing the forces and materials of nature for the benefit of mankind by scientific design and efficiently directing human effort.''.

''The four qualities considered thus far—appreciation of English as a tool, engineering aptitude, capacity for writing, wide acquaintanceship—have a direct bearing upon the actual machinery of conducting classes. These give the instructor his method of leadership, for they create in his students coöperation and a desire to work. Through these he has his direct relations with his men. The fifth qualification is a phase of personality in the English instructor that gains from the faculty of the engineering college the confidence, the active coöperation, the constructive criticism, and the further stressing in all the technical courses—as a part of every course—of the need and the value of good English for the engineer. This backing from the engineering faculty aids the English teacher in making his course an integral part of the curriculum of the technical college. Indeed, this support is necessary to his success and to a well rounded course in engineering.

The last qualification of the English instructor is one that has not yet been fully recognized and utilized. Indeed, it has as yet been suggested by no one. The vocational guidance should be present in every good instructor of technical students. The English teacher, however, is likely to have the most accurate and extended information. He pretty generally deals with the first-year men; he has the best source of any instructor of freshmen from which to obtain an intimate knowledge of the aims and the aspirations of these men, their previous experience, their immediate difficulties and shortcomings. No other instructor of freshmen engineers, except perhaps the instructor of general engineering drawing, receives as much tangible evidence from every student. The instructor in English, through the personal conference with each student which is a necessary part of the teaching, and through the weekly themes which are written on carefully assigned subjects of a more or less personal nature, acquires a very detailed and definite knowledge of his students. To the experienced teacher, the themes have much significance, for they indicate pretty accurately the student's state of rest or unrest. The personal conference checks the impression gathered from the themes; consequently the instructor can make some very reliable assumptions. Surely it is worth the effort on the part of faculties of colleges of engineering to appreciate the means that they have at hand of securing the results of intelligent study by a person with training, insight, balance, breadth, judgment, culture and character; and to study closely and demand the selection of those teachers of English who have this vocational guidance instinct. The fatalities among first-year men are great; the unrest and often openly expressed dissatisfaction among fourth-year men are too wide spread. The results of the Alpha Army test and of the engineering aptitude test have not extended over a long enough period to have yet final significance. Few colleges also have applied them very far in the study of each individual. Until the data of these tests can be given extended application and until colleges can give more time to the study of the individual, there is need for some one somewhere along the line to apply the rudiments, at least of vocational guidance to save every one time and effort. The teacher of English has the facilities now for the elementary application as a natural and necessary part of his instruction in English. If wisely selected because of the special qualifications previously considered, he will have the information available for immediate use. Until some more competent person is found who can devote all his time to this vocational guidance study, the well qualified instructor in English is the best trained and the logical person to speak authoritatively upon the inherent assets and liabilities of the students.

A few other qualifications of the English teacher ought to be mentioned in passing—geniality, some industrial experience which will temper wisely his academic eccentricities, a knowledge of students from all the other colleges in the university before he specializes in the teaching of technical students, and well demonstrated executive ability.

The use of the course in English has many possibilities for engineering college and for the student. It behooves the faculty of the college of engineering and departments of English, therefore, to give careful consideration to the teaching of this subject, and to appoint only those teachers who measure up to the general qualifications and to the specific ones; those who have maturity, wide experience, and a variety of interests. If young and inexperienced teachers have to be used, they should be under the supervision of one English teacher who can develop these new teachers into the kind that are needed. But the work ought to be rated high enough to hold for more than a transitory year or two, competent, progressive men and women who are willing and eager to spend and to be spent in the teaching of English to technical students. If engineering faculties and engineering societies would state definitely what they need, take active steps toward recognizing English as fundamental to successful engineering practice, and ask for the teacher with the special qualifications instead of accepting whoever is sent to them, they could raise the standard of English teaching in all engineering colleges and give encouragement to those teachers already giving instruction in English to technical students. Concerted, definite taking of stock and coöperation between engineering faculties and departments of English are desirable. There are tractable students. There are well qualified teachers of English. Engineering educators should urge that these qualified instructors should have the opportunity to contribute generously to the training of the future engineer.

DISCUSSION.

Professor C. W. Park: Mr. President, and Members of the Society: Perhaps the committee's most important contribution has already been made, although you may not be aware of it. In releasing Professor Nelson, who is a member of the committee, in order that he might devote his time entirely to entertainment work, the committee feels that it really has contributed something important to this convention already.

The original plan was for Professor Nelson to present a paper at this time, and I expected to sit back and listen. I shall, however, since this change has been made, present a part of our data, and shall ask, another member of the committee, Miss Harbarger, to present briefly a second part in which some of the members have expressed special interest. I should like at the outset to refer to the way the work of the English Committee ties in with the discussion this morning. Mr. Coler made a direct reference to the importance of English as a part of the equipment of young engineering graduates. Even a closer connection was suggested in the paper presented by Professor Newell. I think it is becoming increasingly evident—the reports we have received all indicate this—that unless the engineering graduate is capable of articulating his thought for the general public, he is not going to be appreciated. He is, as those of us who are closely associated with engineering recognize, the most important factor in modern civilization, but he is also by and large what may be called a silent partner in civilization. Unless there is some means of presenting in a dignified way the work that the engineer is doing, the recognition to which is so well entitled will not come to him. I should like to say parenthetically it has been my observation, and that of a good many others from whom I have heard, that you will get salary by getting recognition, first, rather than the reverse. Anybody who has noticed how some political jobs have been filled will recall that it is not possible to dignify a person or make him competent merely by giving him a large salary. The first thing is his demonstration of his fitness, of his service, and the only way the public ever will find out about that is for the engineer to become articulate, as Morris Llewellyn Cook did in his famous report made to the City of Philadelphia. It is that phase of preparation in English with which the Committee has been most impressed. The part I wish to present is the report of progress of the investigation made during the present year.

REPORT OF COMMITTEE NO. 13, MECHANICS AND HYDRAULICS.

CORRELATION OF COURSES.

BY O. H. BASQUIN,
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On May 3 and 4, 1920, a conference was had at Iowa City, Iowa, between Professor Stewart, chairman of the Committee on Physics, and Professor Basquin, chairman of the Committee on Mechanics and Hydraulics.

The topic of discussion was Correlation of Courses, particularly Correlation of the Mechanics Portion of General Physics and the subsequent course in Mechanics, and still more particularly whether the proposed coöperation of the two committees in making a combined syllabus, table of contents or dictionary, is appropriate and practical.

These notes are intended to record briefly some of the views of the chairman of the Committee on Mechanics and Hydraulics.

The courses of instruction may be said to be correlated if each instructor understands the aim of the other and if he so plans his instruction as to accommodate the aim of the other instructor as well as his own.

Lack of correlation appears to be a natural result of specialization and of the division of the forces of instruction into separate departments according to topics of specialization. In specialization one narrows his point of view to his own topics; his judgment becomes excellent on these topics but it may be poor on others. Instructors in allied departments naturally develop different points of view; they take pride in developing superior points of view and they naturally plan their instruction to suit the points of view of their own departments. Thus arises a lack of correlation.

In a comparatively young institution the lack of correlation is likely to be less marked. The number of departments is smaller; specialization has not become so marked; the small number of instructors gives each a better opportunity to learn the views of others, and it is possible for each instructor to see that the success of the institution depends more upon coöperation than upon brilliant teaching in one topic that may not fit into the general plan.

The lack of correlation is therefore looked upon as the natural result of the common plan of organizing highly specialized instructors into separate departments. Assuming that the lack of correlation exists, how may this lack be overcome? How may correlation be introduced?

There seems to be a tendency in some institutions to demand that engineering students shall receive their instruction from engineering instructors, men of engineering training if not of engineering experience. A few years ago, the students of medical schools received practically all their instruction from medical instructors; this is now in process of change to a scheme whereby liberal arts instruction is required of such students before entering medical schools. It is not evident that engineering students can afford to miss the liberalizing influence that may come from contact with instructors who are not engineers; it is not believed that this plan for the introduction of correlation is of general application.

Further, it is not believed that a suggestion that instructors should be less highly specialized or that any radical change should be made in their organization into departments would be received with favor by any considerable number of institutions. The present arrangements correspond to some extent to modern methods of manufacture wherein distinct processes are conducted by specialists in distinct departments.

The method of manufacture appears to differ from the college organization in that the material operated upon is much more tangible than that upon which instructors work; inappropriate treatment of this material is thus easily detected in manufacturing whereas it is scarcely evident in education and its result may be attributed to the wrong cause. The differences pointed out naturally lead to closed coöperation between departments in manufacturing than in education; and in manufacturing that difference of opinion between departments leads to a prompt and effective decision by the administration: differences of opinion in manufacturing are not allowed to interfere with consistent processes.

In college organization the different departments in one college are supposed to be bound together by the dean of that college; it is his business to see that the departments work harmoniously; that their instruction be correlated. The dean's authority may not extend beyond his own college. If correlation is to be established between two departments in different colleges, it seems necessary, according to the rules, to enlist the influence of the deans of both these colleges in favor of such correlation, or to carry the question to the president of the institution. This is an awkward process for the purpose, to say the least. But since these officials represent the correlating influences in the organization, I think is essential that they realize that effective correlation can become general only through their action in its favor.

If the instructors in two courses desire to establish correlation in their work, what is to prevent their doing it? The conditions for correlation are given in the fourth paragraph of these notes. The instructors are on the same campus; they meet frequently; a few conferences on the subject will make clear to each instructor what the general aim of the other is; an exchange of textbooks with marks at important parts will lead to a thorough understanding. Given the desire to introduce correlation, I see no considerable obstacle to its effective and prompt introduction. The one lack is the *desire;* the desire on the part of *both* instructors. To introduce correlation, the first thing that is to be supplied is the desire to do it. I think that this will not arise in the minds of both men spontaneously and simultaneously. This desire must come from another source. It must come from the correlating official of the institution. Each instructor must be told by his own dean that correlation must be introduced; that the dean does not care how differences of opinion are settled between the departments, but that consistent instruction must be introduced without delay.

Professor Mann's Report on Engineering Education contains an interesting account (page 30 of the means used at University of Cincinnati to develop "a very effective coördination of effort among the several departments." It is there stated that similar efforts are being tried at Sheffield Scientific School and at Stevens Institute.

The course in General Physics is commonly given to engineering students in the sophomore year; about 30 per cent. of the time for this course is devoted to the study of mechanics. Mechanics is an essential part of physics because other parts of physics are not considered as explained satisfactorily until they are solved in terms of mechanics. This study of mechanics covers the fundamental principles, it commonly embraces experimental lectures done before large classes, some individual laboratory work, recitations on a text, and the solution of some problems. This work is conducted, in general, under the direction of the physics department.

Instruction in mechanics is continued in a separate course and quite commonly under the direction of another department. In this further work the main object is to give the student a working knowledge of the subject whose fundamental principles have been studied already. Comparatively few new principles are taught the student in this second course, but many applications are made. It is customary to use a different text from the one used in Physics and in this text the subject is treated as a whole, *de novo;* the principles are again explained (perhaps using more mathematics and a somewhat more advanced view) instead of referring the student to his former text.

The teachers in this mechanics course may be young engineers with a couple of years of practical experience; they may not know the points of view of the physics instructors in that institution and they may care less; they may have found that certain points of view in mechanics have been essential in their experience in practice and they are determined to make these points clear to their students. This mechanics course differs from the physics work in that subject, in point of view and in method of instruction—the solution of numerous problems of a practical nature.

In January, 1917, the Physics Committee made a report to the Committee on Mechanics, in part, as follows:

"The Committee on Physics very much regrets the general lack of coöperation between the two courses in mechanics . . . ."

"It realizes that this lack of coöperation is due to the lack of knowledge (on the part of the instructors in physics) of succeeding engineering courses and of actual engineering problems, to the lack of knowledge (on the part of the instructors in mechanics) of the material studied in the course in physics, to the apparent lack of knowledge on the part of the student in passing from one course to the other, and to the lack of recognition of the necessity of repeated reviewing if the student actually is to acquire a *working knowledge* of mechanics."

"It realizes that coöperation in the preparation of a syllabus on *mechanics* is highly desirable as a method of influencing the coöperation which should exist between the two courses."

The report closed with a recommended plan for the preparation of the joint syllabus. The former Committee on Mechanics approved the undertaking. In December, 1917, the

Committee on Physics presented to the Committee on Mechanics its portion of the proposed joint syllabus on Mechanics; and the approved plan provided that the Committee on Mechanics would furnish additional material indicative of the work of the second course in mechanics. This material was not furnished promptly and the Committee on Mechanics was reorganized the following June. The following December the matter of the joint syllabus was brought to the attention of the present Committee on Mechanics and Hydraulics. This committee had other work laid out for last year. Its position regarding the proposed syllabus has been unsatisfactory; apparently its members looked upon it as work that ought to be done out of courtesy to the Physics Committee and because the preceding Committee on Mechanics had approved the undertaking. However, no member showed enthusiasm and all appeared to be busy with duties that seemed more important. The matter was brought to a head by the request by Chairman Stewart for the conference referred to at the beginning of these notes.

The writer does not believe that the preparation of the proposed syllabus would have any material influence in bringing about the desired correlation of courses. Correlation in any one institution should be made by the adjustment of courses to one another as they are actually given in that institution, and not by the adjustment to some proposed standard that does not fit the condition that are present in any one institution. The proposed syllabus does not supply the motive for correlation on any one institution, whereas the writer believes that the motive for correlation is the one essential requirement for its establishment.

The writer believes that the subject of correlation of courses is worthy of the attention of the Society. He believes that a campaign should be organized for the purpoe of calling attention to the importance of the subject and to the necessity of securing the assistance of the proper officials to provide the motive. He thinks that papers should be published upon the attempts that have been made to secure correlation in various institutions with the results obtained, and that definite institutions be approached for the purpose of having experiments in correlation attempted for the good of the institution and for the information of the Society in attempting to develop this work.

REPORT OF COMMITTEE 14, ECONOMICS.

The Committee was assigned no specific work by the Society and has no definite recommendations to make, but desires to submit as information certain observations concerning the teaching of economics to engineering students.

These observations are not intended to be recommendations as to methods of teaching, for teachers of economics have their own methods; they are rather meant to indicate the results which in an engineer's judgment, may be most beneficial.

POINT OF VIEW IN TEACHING ECONOMICS TO ENGINEERING STUDENTS.

In this connection, the following statements of opinion are offered by the Committee:

1. The introductory course of three credit hours as recommended in the 1918 report, should consist essentially of the elements of economics, and be of such a content that it might satisfactorily serve as a basis for further study in advanced courses.

2. In the adjustment of time given to the major divisions of the subject, primary emphasis should be placed on Production.

3. Anything in the nature of *applied economics* as related to engineering, should be administered through the regular engineering departments just as the applied physical sciences are administered.

In support of this opinion, attention may be called to the fact that most text books as well as most professors of economics at present are chiefly or primarily concerned with the *distribution* of the nation's wealth and the products of industry rather than with the production of this wealth, and therefore, they stress the former phase of economics above the others. Exchange and commerce and the agencies thereof probably take second place in their estimation and consumption with the consideration of the nature of human wants and the elements of value assigned to third place, leaving production to receive the least attention of the four major divisions of the subject of economics. This is not their relative order of importance as they pertain to the profession of engineering. The engineer is more concerned professionally with production of the foods than he is with the equitableness of their distribution, his interests in the latter being that of any citizen. He is interested, therefore, in the economic forces which stimulate or retard production. Are personal initiative and group efficiency promoted by private control of the sources of production rather than by government control to the end that production is increased and made more efficient? What taxes are purely fiscal and what are regulatory and do some forms of taxes unduly retard production? Is output restricted and diminished by certain laws intended to regulate industry? What effect do adequate facilities for commerce have on production? Do combination of capital on the one hand and the unionization of labor on the other affect production? Do high wages with better standards of living increase production over low wage conditions? This sort of questions illustrates the professional viewpoint of the engineer with regard to economic questions. For example, the engineer professionally is primarily interested in wages as they affect production through their influence on workmen's efficiency and otherwise rather than in the general social problem as to whether they represent the just share of the products of industry that should go to labor. In the latter, he is interested as a worker himself and as a citizen, but the former phase bears on his professional activity. For this reason it is less important for the engineering student to study at great length the various economic factors that determine labor's return than it is to know the agencies which under existing conditions actually fix wages. That is, it is less important for him to follow through the arguments of those on the one hand who believe that labor's share of the products of industry (wages) is determined by "marginal utility" or "marginal productivity" of labor and of those on the other hand who contend that the "living wage" theory as advanced by Marx, Ricardo and Smith is the determining factor, than it is for him to know that wages are actually determined in any industry by the facilities for bargaining between employees. The engineer is interested primarily in profit sharing, industrial partnership, etc., in so far as these devices may affect labor turnover, labor efficiency and ultimately, on the cost and quantity of production. In other words, the Committee feels that valuable time may be unwisely spent in classes of engineering students with comparatively immature judgment in a discussion, as the primary basis of a course in economics, of many of the advanced socialistic notions of distribution rather than in the consideration of the fairly well-established principles of productive industry and of commerce.

Attention should be called also to a possible danger that may arise in leaving an engineering student with only a brief outline or survey of economic thought which must necessarily be rather superficial, unless such survey has been skilfully administered. This student is not, generally to have the benefit of further formal studies in economics, hence, the instruction should be made as pointed and definite as possible, and loose sends of ideas and concepts should be caught up and such concepts cleared and chastened perhaps more systematically and rigorously than in the case of liberal arts students who intend to delve more deeply into the philosophy of economics. Unless this is done, inaccurate and muddled thinking may be the result of the course instead of clear cut logic that is so much desired. Economics deals largely with general averages, and the student with a smattering of economic factors may talk glibly of glittering generalities, about "movements," "trends," "tendencies," "waves," "tides," "streams," "currents," "drifts," etc., and yet may mistake a patch on a man's trousers for a "wave of economy." Therefore, accuracy of observation, clear and direct thinking, and discerning judgment in analysis should be striven for in instruction, with an effort to separate the revelant from the irrelevant, in considering any particular question, rather than to arrive at certain preconceived conclusions of more or less dogmatic character, which may after all, be more dependent upon the professor's experience and training than upon an unbiased survey of facts. Most questions of political and social organization, after being brought to the attention of the class and having their significance indicated, instead of being "settled" by the teacher, would best be left to the further reading and observation of the student with the mental road left open for each to arrive at his own final conclusions.

Improved Psychology in Teaching Economics.

That a good deal of time has not been well spent in the teaching of economics in attempting to project modern motives and wants back into primitive conditions of social organization is doubtless a fact. A consideration of modern motives, wants, processes and methods together is certainly more rational than to attempt to draw conclusions from the application of modern motives to primitive methods, because the motives that actuate men change with the development of social organization. Whereas a savage was actuated almost solely by elemental desires, the modern man is actuated by a complexity of wants, both natural and artificial, arising from the complex means of supplying and satisfying them; hence, to attempt to arrive at safe conclusions applicable to modern society by projecting present day motives back to the conditions of savages, swapping nuts for fish, building a wigwam, making clothes of skins and bark, or of Cruso's relation to his man Friday, may be agreeable mental diversion, but is likely to be barren of usable results applicable to existing conditions.

Happily this sort of teaching of economics does not prevail to the extent that it once did, and both texts and professors devote their discussions more to actual conditions of the present industrial and social world, and attempt to connect modern complex wants and elements of value to the existing complex modes of supplying them, and to recognize, for example, the function of business ability and of organization as applied to quantity production as distinguished from the crude coöperation of a few members of a savage tribe.

The average engineering student is not familiar with business methods and the agencies and instrumentalities for conducting the economic and industrial affairs in the modern world and the instructor should take advantage of every opportunity to impart instruction along this line by using as illustrative material definite and accurate information concerning commercial processes instead of framing hypothetical and unreal situations as they may occur to him at the moment. It is true that to teach a class in this manner will require special effort on the part of the instructor even though he may be able to discuss generalities from his knowledge of the subject. The chief cause of the lack of interest on the part of engineering students is due largely to the pointless instruction of instructors who lecture out of their inner consciousness and general knowledge of the subject rather than put forth the effort to prepare specifically for this elementary instruction.

Present Status of Courses in Economics.

Two years ago, this Committee recommended that a three semester hour course in general economics be required of all engineering students, and submitted a tabular statement of the prescribed courses in economics at various institutions at that time. A revised study of conditions indicate that a few schools not requiring economics then have since introduced courses and that apparently none have reduced the amount of time devoted to the subject. Some have introduced courses in what may be termed *applied economics,* such as management, administration, costs and ratemaking, valuation, etc., taught by members of the engineering faculty. The opinion of the Committee, based on the observation of only a few cases, is that these latter courses, where taught by a professor of engineering of broad professional experience, are of much value.

As indicated in the 1918 report of this Committee, some engineers and writers appear to confuse *economy* or *economics of design, construction and operation,* which takes into consideration the factors affecting the cost and financing of engineering projects, with *economics* or *political economy* as the term is employed by collegiate faculties. There is a danger of rendering the term *economics threadbare* and meaningless by its promiscuous use, and this resulting vagueness of the term has apparently led some to suppose that collegiate departments include many subjects in their curricula which as a matter of fact they are not equipped to teach nor do they make any attempt to do so.

COMBINED COURSES OF COMMERCE AND ENGINEERING.

Somewhat over a year ago, certain conferences were held under the direction of the Bureau of Education to foster the development of courses involving a combination of technical subjects with economics as preparation for managerial positions. A few schools have instituted such courses, as related in last year's report, and this list has been slightly increased during the year. All these courses, except perhaps that at Carnegie's Institute of Technology, are fundamentally courses in engineering with economics and similar subjects submitted for some of the more highly specialized technical subjects. In one instance, at least, the courses in economics are added as a fifth year to the regular engineering curricula, and in another, the combined course is of six years' duration coördinate with the other technical courses at the same institution.

While the Committee is not prepared to offer an opinion as to the feasibility of such courses generally, it appears that the interest, as indicated by the number of students enrolled in them, is greater in the populous manufacturing and commercial centers than it is in the mid-west institutions. Massachusetts Institute of Technology, for instance, reports a growing enrollment in its course in Engineering Administration, while two mid-west universities have practically no demand for similar courses. This is the situation that would naturally be expected from the circumstances.

The Committee believes that the application of the term "Commercial Engineering," as proposed by the Bureau of Education to courses in schools of commerce, which include a small amount of informational study in engineering methods and processes, is undesirable, because "engineering" has through the past century taken on a fairly well defined meaning, and to apply it loosely to the specific operations and procedure of commerce, to salesmanship, of miscellaneous goods, to advertising, accounting, etc., is but rendering the term more meaningless as signifying a profession.

J. W. DIETZ,
A. M. McDANIEL,
E. B. PAINE,
P. F. WALKER,
C. C. WILLIAMS, *Chairman,*
Committee.

The Committee begs to submit as an Appendix to the above report, the following brief paper on "Teaching Elementary Economics to Engineering Students" by William M. Duffus, associate professor of economics at the University of Kansas, who has taught the economics classes for engineering students at that institution during the past year, and who has given considerable thought to the character of instruction best adapted to the conditions.

TEACHING ELEMENTARY ECONOMICS TO ENGINEERING STUDENTS.

BY WILLIAM M. DUFFUS,

Associate Professor of Economics, University of Kansas.

In compliance with the Committee's request the writer is glad to state some of the opinions which he has formed concerning the problem of teaching economics to students of engineering. However, he wishes it understood that his opinions are the result of but one year's experience with the problem and that some of them are tentative conclusions rather than expressions of final judgment.

First of all, it seems to the writer, the committee is to be congratulated upon its discernment in emphasizing the necessity for thorough drill in what are generally accepted as the fundamental principles of economics. The engineer, if he is to rise to his opportunities for personal advancement and for service to others, needs to have a good grasp of these principles and a reasonably accurate knowledge of the nature and problems of modern economic institutions. He can best get these aids to efficiency as the rest of us can best get them—by the study of economic forces and economic institutions as they are found in the world at large. It is no more possible to *divide* the *principles* of economic science successfully into economics for business men, economics for farmers, economics for engineers and economics for apothecaries than it is to divide the principles of the physical sciences in the same way.

Although all students studying economics need to study the same fundamental economic principles, whatever the professions for which they may be preparing, they do not all need to approach the subject in the same way. In fact there are distinct advantages in using methods of approach which differ more or less in accordance with the experience, maturity and interests of the student. The maintenance of courses exclusively for students of engineering would seem to be an aid to good instruction.

It must also be admitted that *after* the student acquires a knowledge of the fundamental principles of economics he may reasonably be permitted, within pretty broad limits, to apply that knowledge and make further inquiries in the fields of economic activity in which he is professionally most interested, even though he has to neglect other fields. To illustrate, the student of agriculture may reasonably be given special instruction in rural credits and the marketing of farm products; the student of engineering may just as reasonably be given special instruction in the problems of industrial relations, the regulation of railroads and public utilities, and the organization and financing of business enterprises. But, it may be remarked parenthetically, there will be little opportunity for any instruction in these or in certain other very important phases of economics as long as the present limitation of the time given to economics to a maximum of three hours per week for one semester prevails. The writer earnestly believes that the extension of the time for the course from three to five or six hours would more than double the value of the course.

Taking the situation as it stands, the use of the class discussion method of instruction, with assigned readings in one textbook and in one or more books of readings and frequent short written quizzes, will probably give the best results. There should be at least one section for every 35 or 40 students. The instructor, especially at the outset of his work, should make an especial effort to explain specifically how and why a knowledge of economics is essential to the engineer and should point out from time to time as he develops his subject the importance of the different phases of it to the engineer. He should be as direct and concise as possible in his own share in the class discussion and should use concrete and up-to-date illustrative material. He should avoid the elaboration of fine-spun theories in matters of controversy in so far as it can be done without sacrificing scientific accuracy. For it must be remembered that the student of engineering is training himself for a very practical life and not for a life as a speculative philosopher.

It is probable that a textbook especially designed to meet the needs of students of engineering would be a material aid, if properly written, in the teaching of economics for engineers. Such a book should be written by an economist who has had experience in teaching engineering students and who knows something of their psychology and the difficulties which they have in grasping the subject. It should be written with the point of view of the student constantly in mind. It may be difficult, however, to induce any competent economist to undertake the task as long as the present time limitation on the work of the course remains effective.

The writer has used Ely's "Outlines of Economics" as the text this year and has assigned additional readings in Marshall, Wright and Field's "Materials for the Study of Elementary Economics." Such collections of illustrative material as are found in Marshall's "Readings in Industrial Society," Hamilton's "Current Economic Problems" and some of the more specialized books of readings might well be used as additional references. The writer has found it inadvisable to depend upon any one book of readings. In fact he is among those instructors who are desirous of seeing some plan for the provision of loose-leaf, up-to-date illustrative material worked out as an experiment. In this connection readers may be interested to know that a committee of members of the American Economic Association, chosen from among instructors of elementary classes in universities and colleges, is studying the possibility of establishing such a plan.

There is a disposition among some teachers of economics to regard students of engineering as particularly hard to teach. The writer's experience does not warrant this belief. If the instructor receives proper support from the school or departments of engineering and if he approaches his subject with proper consideration for the psychology of his students and with proper enthusiasm on his own part he should be able to obtain results that will compare favorably with those obtained in teaching academic students or students preparing for commercial pursuits.

REPORT OF COMMITTEE NO. 15, CIVIL ENGINEERING.

SUBJECT: METHODS AND DETAILS OF TEACHING STRUCTURAL DESIGN.

The above subject was assigned to the Committee nearly three years ago. A progress report including three formal papers, was presented at the Evanston meeting which, with discussion, appears in the 1918 *Proceedings.* The work was continued during the following year primarily by means of discussions by Messrs. C. E. Fowler, J. A. L. Waddell, H. P. Gillette, Gustav Lindenthal, O. H. Basquin, S. C. Hollister, Edward Godfrey, and F. E. Schmidtt. These were published in the April and May (1919) numbers of the BULLETIN, but not in the *Proceedings.*

A report, which was regarded by the Committee as a final one, was presented at the Baltimore meeting which, with discussions was published in the 1919 *Proceedings.*

This report contained a "Summary of Conclusions" which, by vote of the meeting, was made a part of the program of the 1920 convention for discussion and possible adóption.

The Committee has given an attentive ear to the discussions and, with further study, takes the liberty to make one slight change and two additions to the Summary as presented a year ago. It therefore presents, for approval by the Society, as the principles which should be considered in planning and administering the structural courses of a curriculum in Civil Engineering:

1. The general curriculum in Civil Engineering should be fundamental in character and broad in scope.

2. The structural courses should be considered as a part of the general curriculum and not as independent courses.

3. The structural courses should be so comprehensive and at the same time so fundamental that they will enable the student to understand the main feature of the design of structures and, at the same time, serve as a basis for future specialization in college or in practice.

4. The required structural courses should include:

(*a*) Mechanics, including statics, dynamics, and mechanics of materials.

(*b*) An experimental and physical study of the usual materials of construction, including iron, steel, timber, cement and concrete.

(*c*) The theory of reinforced concrete construction with just sufficient design to illustrate and fix the principles involved.

(*d*) An analysis of stresses and deflections in framed structures from a general standpoint which may be extended, when desired, to any structure, for dead and live loads.

(*e*) The principles underlying the design of sections and of details with just sufficient work in design to illustrate and fix those principles.

(*f*) An introduction to the principles of estimating and to the procedure of producing structures.

5. Elective structural courses should be provided in accordance with the policy and the needs of the individual institution.

6. The methods employed should be such as to arouse the student's interest and be directed towards the discovery and development, by the student, of the principles involved, rather than to "teach" him certain standard theories and methods.

The slight change mentioned above consists of dropping the words "statically determinate" which preceded "structure" in 4 (*d*). The discussion has brought out the fact that in a number of required courses including those given by two members of the committee, the stress work has been extended to some statically indeterminate conditions with apparent success. The change does not necessarily recommend this procedure, but it specifically removes a recommendation that statically indeterminate work be excluded.

4 (*f*) was added to meet a demand, championed particularly by Professor McKibben at the Baltimore meeting, for giving the student an insight into the shop and managerial problems involved in producing structures and for calling attention to the need of considering estimates in connection with the structural courses unless provision has been made elsewhere in the curriculum.

5 has been added to cover the demand from certain sources for additional work. The committee feels that further requirements in structural lines, accompanied by similar ones in railroads, water supply, sewage, etc., would defeat the purpose of a strong fundamental course, but recognizes that a certain amount of specialization may be desirable for some men at some places and that this can best be provided for through electives.

Respectfully submitted,

A. H. FULLER, *Chairman,*
W. C. HUNTINGTON,
H. T. BURT,
C. T. MORRIS,
J. HAMMOND SMITH,
Committee No. 15.

DISCUSSION.

M. S. Ketchum: This subject was assigned to the committee when I was president of the Society. I have given considerable attention in teaching structural engineering to the development of the courses along the line of scientific management. While considerable progress has been made in the application of the principles of scientific management in the industries, there has been little or no attempt to apply these principles to teaching. With a definite outline for the courses and with detail instructions, the instruction in structural engineering can be made much more effective. I am very glad that the committee has included a study of statically indeterminate structures in their proposed outline for the course in structural engineering. I am in favor of approving the proposed outline for the course in structural engineering.

Professor Constant: I spoke upon this report last year and regret that the discussion was admitted to the *Proceedings* without being previously edited. It must have seemed rather unintelligible gibble to the reader in more than one place.

Rather, however, than take up time at this meeting with a revision of that discussion, I should like now merely to repeat that I was in general accord with the report of Committee No. 15, except that I believed that the analysis of stresses and deflections (under 4 *d*) should be extended to include statically indeterminate as well as statically determinate structures.

The present report has been corrected in this respect by omitting the words "statically determinate" which preceded the word structure in 4 (*d*). I therefore second the adoption of the report as it now stands.

REPORT OF COMMITTEE NO. 17, ELECTRICAL ENGINEERING.

The close of this university year finds the schools of electrical engineering unable to meet the demands made upon them for technical graduates. This is no doubt true in the other branches of the engineering profession as well. In the face of these facts the mortality during the college course is greater than ever and the number of trained engineers entering positions in other fields than engineering seems to be upon the increase. The causes for this condition may be listed as follows:

1. Necessarily poor preparation in lower classes in college and in secondary schools during the war.
2. Inadequate recognition of the value of the trained engineer as compared with the salesman and laborer, particularly by the large manufacturing and utility corporations.
3. Failure to employ sufficient technical graduates in less prosperous years to adequately man the staff of such corporations when demands upon such men are exceptionally heavy.
4. Difficulty in eliminating, both at entrance and during the course, students not well fitted for successful engineering work.
5. Lack of adaptation of engineering courses to the best possible preparation for the work to be undertaken by graduate engineers, particularly in connection with present day demands for so-called "sales engineers" and "engineering executives."

If these causes are to be analyzed briefly, it will be observed that the first defect will automatically take care of itself in a year or so, now that the war is over.

Conditions mentioned in paragraphs (2) and (3) are principally without jurisdiction of the schools, although it is believed that a committee of this society might coöperate with the representatives of large corporations to mutual advantage.

With regard to the two last causes, the technical schools are distinctly at fault. It is hoped that measures will be taken speedily to remedy such defects. Many institutions are introducing courses in the fundamentals of business and law to great advantage, for the successful engineer must be acquainted with both. Although it may be argued that he can readily acquire such outside the four years' course, he is often unmindful of his lack of such training. He is inclined to assume that if he is not taught such a subject it is of secondary importance. Is this the truth of the matter in this day and age? Ask yourselves if all the subjects in your curriculum are as valuable as the fundamentals of corporation management and law.

Alumni, generally speaking, will insist that standards of entrance should be raised, if anything, rather than lowered and that quality is of more importance than quantity. Secondary schools, with their increasingly diversified curricula, although offering the required number of units for entrance are not rapidly improving the fundamental preparation for engineering. It is believed that a committee of this society may gradually develop engineering tests of value for entrance and for elimination of the unfit from the courses in engineering before they have proceeded too far along the pathway of the mediocre engine.

Courses in electrical engineering are correlating laboratory tests and theory more closely than ever before. The so-called problem course is proving very effective. How far shall such instruction be carried?

Many years ago Professor Karapetoff of Cornell University presented this theory of "concentric instruction" before this society. Although considered a radical departure at the time, educational methods at least in engineering are tending in that direction. In Germany, where technical training is very effective to say the least, such methods are being adopted.

Let us ask ourselves whether or not the experiences of the war training did not lend valuable emphasis to "motivation" in our instruction as outlined in a recent paper before this society by Professor W. K. Hatt. Shall we not have at first an intense interest in a practical engineering problem on the part of the student, followed by an attentive mastery of he underlying theory, as a result of the incentive created by the practical problem or situation itself?

A third consideration of moment is the extent to which electrical engineering education shouud be connected up with industry. To what extent should such students have industrial experience before graduation? At what time in the course should such experience be secured? It is generally recognized that to classes of 1920 and 1921 which include many more mature and experienced students than usual, as a result of war-time activities, are better prepared to take up responsibility than the average graduate in times of peace. Does this fact warrant further coöperation with industry during the technical course.

Furthermore, particularly in state institutions, increased coöperation with industry will be value to industry itself in the solution of its problems and to the instructional staff as a result of the enlivening influence of up-to-the-minute technical applications. Should not these contacts be encouraged and developed in accordance with a definite program for the mutual benefit of all concerned?

Four fundamentals of administration, believed by your committee to be vital have been proposed for your consideration. They are uppermost in the minds of many members of this society. It is hoped that a discussion setting forth the valuable experience from many institutions may result.

O. J. FERGUSON,
ALEXANDER GRAY,
H. E. DYCHE,
F. T. DARGAN,
E. J. BORG,
H. B. SHAW,
C. F. HARDING,
Chairman.

REPORT OF COMMITTEE NO. 18, MINING ENGINEERING.

The general mining engineering profession is less specialized than any of the other engineering professions. Its own field takes in many of the others. Its growth and development have been so comprehensive that its subdivision into Mining Engineering and Metallurgical Engineering is already well advanced, although this Society still holds it under the parent name. The extraction of ores from the earth is especially mining engineering, while the treatment and reduction of ores is especially metallurgical engineering. There are a number of specialized branches of the former, such as coal mining, metal mining, hydraulic mining, etc.; and there are two well defined divisions of the latter into furnace engineering and milling engineering.

The profession in general has to do with civil, mechanical, electrical, hydraulic and chemical engineering; and in addition to the first four of these branches of engineering, it requires in its digging operations knowledge of the science of mining and of geology, and the solution of the problems of handling and controlling stupendous mass weights and movements.

The operating mining engineer will further require a knowledge of business science, and skill in organization and employment.

What then, may we enquire, is the best possible training to be given the undergraduate mining engineer in the time usually allotted, and what shall be done to bring about desired improvements?

Five different topics have been suggested for the discussion of this question, as follows:

1. The standardization of methods of teaching.

2. The improvement of the standard of instructional work.
3. The designation of essential equipments for mining, ore dressing, and metallurgical laboratories.
4. The discouragement of the further establishment of mining schools where not needed.
5. The amplification or revision of the mining section of the report of the Committee on Requirements for Graduation, published in 1904 and 1905, Vols. XII and XIII.

The first has special reference to the coördination of class room and laboratory instruction, laboratory methods, and field practice.

The second topic involves two correlative propositions: on the one hand, the improvement of instructional ability and equipment; and, on the other hand, the improvement of the quality of student. The one is largely a question of compensation and price; the other may be accomplished, perhaps, by careful selection and by reaching back with greater attention to early training. Instructors of the specialized, or applied, subjects should themselves be thoroughly trained in the fundamentals, and understand the relations between the two classes of subjects. Moreover, it would be best if the teachers of the fundamental subjects had a thorough knowledge of the applied; but this would be an impracticable requirement, especially in the large schools giving many different engineering courses.

In approaching the third topic, we may observe that to the engineer a training in capacity for calculation and analysis is essential, capacity for manipulation may be convenient: designing and directing are essential, expert tradesmanship is of secondary importance: a knowledge of business science may be acquired: and an understanding of humanity may be cultivated, but the capacity for it must be inborn. The difference between the trade school and the engineering school should be kept in mind. A man may be an expert miner, mill man, furnace man, or assayer, or all of these, and not be a mining engineer. However, it is usually desirable that the graduate mining engineer should be a good surveyor, or assayor, or chemist, or accountant, etc., in order that he may enter the mining business with a qualification with which he may make himself useful to his employer and incidentally earn a living. The particular line in which the undergraduate may choose to make himself useful may depend upon the branch of mining engineering he wishes to follow, or it may determine for him the branch that he shall follow: but if he is well grounded in the fundamentals, the whole field is open to him.

The essential equipments for the different laboratories are only such machinery and apparatus as illustrate and represent the operations and practices that have become standard, or illustrate some important, fundamental principle. Standard operations and practices that are susceptible to laboratory treatment, are relatively few in number: in mining, they are drilling, blasting, and supporting excavations; in assaying, they are sampling, charging, melting, and cupelling; in ore dressing, they are crushing, classifying, concentrating, and, in some cases, extracting; in metallurgy, leaching and flotation are susceptible to laboratory treatment. But, important, fundamental principles remain matters of individual opinion, and we cannot designate essential equipments for their illustration, except each for himself.

The fourth proposition may be favored on the ground that the establishment of mining schools where not needed is liable to be accompanied with insufficient equipment and support, the employment of inferior instruction, the graduation of men with inferior preparation, and the general graduation of the profession. On the other hand it may be urged that such schools, by calling attention to mining engineering education, turn many good men toward the better schools.

We shall introduce the consideration of the fifth topic by giving a summary of that part of the report pertaining to mining engineering, as follows:

	Hours.
Language	400
Mathematics	800
Physics	700
Chemistry, including assaying	800
Geology and mineralogy	700
Drawing and lettering	300
Surveying and mapping	800
Chemical and metallurgical engineering and ore dressing	700
Structural engineering, statical and mechanical, and materials of.	600
Mining engineering, principally underground	700
Mining engineering, principally underground, and including organization and management	700
Total hours	7,200

The above is designed to cover a general course for graduation in mining engineering, and the first question that arises pertains to the list of subjects; the second, to the proper distribution of time; the third, the detailed subdivision of the subjects; and the fourth, the arrangement of curricula for different specialized courses in mining engineering, such as Coal Mining Engineering, Metal Mining Engineering, etc. Specialized courses in mining engineering appear to be an actual demand of the times that should be provided.

F. W. Speer, *Chairman.*
H. H. Stoek,
E. A. Holbrook,
J. B. Porter,
H. E. T. Haultain,
Committee.

REPORT OF COMMITTEE (21) R. O. T. C.

Your committee, appointed to study the Reserve Officers' Training Corps, begs leave to submit the following report:

The Morrill Act, passed by Congress in 1862, provided that colleges which took advantage of the terms of the act should place in their courses of study the subject of Military Drill and Tactics. All state universities and all state colleges enjoying the benefits of the provisions of this act have, therefore, for many years, required military drill for a period covering from one to four years.

In June, 1916, Congress passed the National Defense Act. A part of this act provides for Reserve Officer's Training Corps units in colleges and preparatory schools, to be known as Senior and Junior Units. Any college or preparatory school may apply for a unit, and the application will be granted if one hundred physically fit male students volunteer or are obliged to take the subject. Military officers are detailed from the War Department to take charge of the instruction. The act provides that during the freshman and sophomore years a minimum of three hours per week shall be devoted to military matters. This is called the Basic Course. At the end of the sophomore year the president and the professor of Military Science and Tactics select certain students to carry on military work during the junior and senior years. If the students so selected choose to accept the opportunity, they pledge themselves to take five hours of military work during each of the junior and senior years; and to attend at least one summer camp. They are given commissions in the Reserve Corps of the Army after graduation. During the last two years they receive a compensation of one ration per day, or about one hundred and ninety-two dollars per year. It is also provided that the institutions where military work is inaugurated may make the work compulsory on the part of students in certain classes or it may be optional. In any case, students who begin the work must continue it for two years in order to be graduated provided the military work is maintained in the institution.

A number of units of the R. O. T. C. were established in our colleges and preparatory schools before we went into the great war. After the declaration of war all officers were needed in the army and hence few, if any, new R. O. T. C. units were started. In October, 1918, the Students' Army Training Corps was organized by the War Department and this took the place temporarily of the R. O. T. C. units. After the close of the war some of the R. O. T. C. units which had been discontinued were re-opened and new units were inaugurated in a number of colleges.

The American people have no genius for military affairs. When the necessity comes they make splendid soldiers and in the end they have always won victories they set out to win, but they do not like war and they do not like military affairs. In the last liberty loan one of the posters represented a workingman with his hand in his pocket saying, "Sure, we'll finish the job." This represented the state of mind of the American people during the war. They wanted to finish the job which they had started out to finish but they had no love for the means which were necessary to accomplish it. A job is something to be finished and then a new job is taken up. The American people having done their part toward finishing the war, concluded the job was finished and took up the new job of peace. We have always adopted a happy-go-lucky method in regard to military preparation—that is to say, we have made little or no such preparation. When a war has suddenly come upon us, we have done our best to get ready for it in a hurry and in the end we have always succeeded in winning. When the great war was over the American army wanted to go home and get into peaceful pursuits again. American students in the army had had all they wanted of military life and when the armistice came they wanted to take up their academic work again.

One of the greatest disadvantages which an unprepared nation experiences, when suddenly engaged in war, is the lack of officers. With a plentiful supply of officers, privates can be whipped into shape in a comparatively short time. Without officers, the job is a very long one. Special regulations No. 44, prepared by the War Plans Division of the General Staff, makes the following statement of the objects of the Reserve Officers' Training Corps:

"*Object.*—The primary object of the Reserve Officers' Training Corps is to provide systematic military training at civil educational institutions for the purpose of qualifying selected students of such institutions as reserve officers in the military forces of the United States. It is intended to attain this object during the time that students are pursuing their general or professional studies with the least practicable interference with their civil careers, by employing methods designed to fit men physically, mentally and morally for pursuits of war. It is believed that such military training will aid greatly in the development of better citizens. It should be the aim of educational institutions to maintain one or more units of the Reserve Officers' Training Corps in order that in time of national emergency there may be instantly available a large number of educated men physically efficient and trained in the fundamentals of military science and tactics and fitted to lead intelligently the units of the armies upon which the safety of the country will depend. The extent to which this object is accomplished will be the measure of the success of the Reserve Officers' Training Corps.

Educational Aim.—The Reserve Officers' Training Corps will enrich the educational resources of schools and colleges by contributing new problems, applications, and equipment. This will not vitalize the course of study but give to the student a training which will be as valuable to him in his industrial or professional career as it would be should the Nation call upon him to act as a leader in its defensive forces.

Moreover, the wide variety of work recognized and accepted by the War Department as of intrinsic value for military purposes should leave on the mind of the student an indelible impression of the extent to which the modern army is the Nation in arms. Commerce, industry, agriculture and all the professions have each their contribution to make to the military organization.

Physical Training.—A military unit is largely dependent for its efficiency upon the physical fitness of the individuals composing it. Physical training, therefore, will form an essential part of the military instruction. It will be the policy to encourage and support the physical training given by civilian teachers, thus coöperating with all other effective agencies in an effort to promote a more vigorous American manhood.

General Policy.—(*a*) The policy adopted by the War Department to carry out the provisions of the act of Congress of June 3, 1916, is a matter of vital importance to every citizen interested in the educational system of our country and the development of American youth. It will aim to give all students of the Reserve Officers' Training Corps a thorough physical training, to inculcate in them a respect for all lawful authority, to teach the fundamentals of the military profession, leadership, and the special knowledge required to enable them to serve efficiently in the various branches of the military service.

(*b*) The War Department aims to establish in selected civil educational institutions a system of training which will tend toward making better citizens and furnish a means whereby the graduates of such institutions can function more advantageously to the best interests of the nation in time of military necessity."

The course of study which has been in use in the basic course of the R. O. T. C. units during the past year has consisted of one hour of military drill per week, one hour of military exercise, and one hour of lecture or recitation on some subject pertaining to military life. It has been an extremely profitable course and has been designed to interest the students in military affairs. Perhaps some statistics in regard to the number of institutions carrying on this work, the plan of the work itself, and the future proposals in regard to it may be interesting. The statistics have been furnished by the War Department.

The questions asked and the answers are as follows:

Number of institutions having units of the senior division		139
New units which have been added during the present college year:		
Infantry	1	
Coast Artillery	6	
Motor Transport	1	
Engineer	4	
Signal Corps	1	
Ordnance Corps	2	
Total		17
Number of institutions in which units have been discontinued		30
Infantry	29	
Coast Artillery	1	
Kinds of units in the institutions and number of each unit:		
Number of institutions	139	
Number of units	205	

Number of Units.	Kind of Units.	Number of Men in Units.
121	Infantry	
	Basic	Ranging from 37 to 1728
	Advanced	“ “ 0 to 218
8	Cavalry	
	Basic	“ “ 10 to 231
	Advanced	“ “ 0 to 75
17	Coast Artillery	
	Basic	“ “ 42 to 265
	Advanced	“ “ 0 to 138
9	Motor Transport	
	Basic	“ “ 50 to 155
	Advanced	“ “ 0 to 9
18	Engineer	
	Basic	“ “ 33 to 347
	Advanced	“ “ 0 to 42
9	Signal Corps	
	Basic	“ “ 41 to 370
	Advanced	“ “ 0 to 38

1	Ordnance		
		Basic	Having 106
		Advanced	" 27
22	Field Artillery		
		Basic	Ranging from 58 to 1195
		Advanced	" " 0 to 40

To what extent is the basic course compulsory and to what extent voluntary in each institution?

Compulsory	98
Voluntary	41

Number enrolled in each institution for summer camp?

132 institutions

Basic	Ranging from 1 to 100
Advanced	" " 0 to 123

What is the attitude of faculty and students in each institution in regard to the R. O. T. C.?

Answer—Information concerning each particular institution is considered confidential by the War Department but it may be stated that, as a general proposition, the attitude of the faculty and students of practically all institutions is one of favorable coöperation.

What changes are contemplated in the work of the R. O. T. C. for the college year 1920–21?

Answer—No definite information can be given until pending Army legislation is enacted by Congress, but the War Department hopes to detail additional personnel to the institutions.

A short questionnaire was also sent to each college (not including state universities) which has an R. O. T. C. unit. The questions and a synopsis of the answers follow:

(1) What is the opinion of the faculty in regard to the R. O. T. C.?

Ans. Of the 38 answers received, 25 were favorable; the remainder were unfavorable or there was a division of opinion.

(2) Have the students liked the work and do they wish to have it continued?

Ans. In 19 institutions the answer was "yes"—in 10 institutions the answer was "no." The other answers show a great difference of opinion among the students.

(3) Have you personally any fault to find with it, or with the manner in which it is conducted?

Ans. The answers were almost unanimously "no." The only criticisms were in regard to the uncertain policy of the War Department in regard to what should be done and criticisms of Congress for not supporting the work better.

(4) Do you expect to continue your unit during the next college year?
Ans. In 27 cases the answer was "yes" and in 8 cases the answer was "no"; in a few cases there was uncertainty in regard to the future.

The answers to both these questionnaires show that military drill is now given in a large number of institutions and that while it has been discontinued in some places, yet in the majority of colleges the work is satisfactory and will be continued; that the number in the basic course is very much larger than the number in the advanced course, as would naturally be expected, but that the number in the advanced course is large enough to prove that a considerable number of men will be trained for commissions in the Reserve Corps of the Army; that in many colleges the students do not like the work but that in the majority of institutions no serious objections have been raised.

In conclusion your committee would say that the plan proposed in the National Defense Act and carried out by the War Department seems to be an admirable one, and that we earnestly hope that Congress will give it so much encouragement that it will become more attractive to the colleges and their students.

DISCUSSION.

Peter Field: Gentlemen, I want to say at the outset that I am heartily in favor of the conclusion reached in this report, namely, that the R. O. T. C. is a good thing and that it ought to be supported. I think that every engineering college ought to get behind this move because by training, the engineers are particularly adapted to qualify for commissions in certain branches of the service, such as the Signal Corps, the Ordnance, Engineers, and the Artillery. It seems nothing short of our duty to see to it that the men who come under our influence shall put themselves in such shape that if their services are needed in an emergency, they are prepared to respond. To be sure, I think, a more or less prominent statesman assured us that in case we were invaded, a million men would turn out with pitch forks and massacre the enemy, but the engineer, I think, believes in the safety factor, and it might be well to have some additional means of protection in case of emergency.

Aside from the thing Mr. Parker has mentioned, namely, that everybody was pretty well fed up on the R. O. T. C. and S. A. T. C., the one other thing that came up as something of a deterent was as to how far the R. O. T. C. work would hinder and encroach upon the regular work that the students had been doing in their under graduate course. I confess we had a good deal of difficulty. We had the material given in this report, but there seemed to be some question as to just how that could be interpreted. The way it was interpreted. The way it was interpreted here, it seems to me, left the matter in such a way that no one would feel that the R. O. T. C. work was infringing upon the work the students previously have taken. The students are at the present time, in addition to the summer camps and the gymnasium work, taking throughout their first two years two recitations a week, or their equivalent. That is, for one recitation, they would make two hours of preparation, and throughout their junior and senior years, one hour a week, i. e., one recitation hour. With that would go two hours of preparation. Now, that seems a very small amount to take out of the regular work, and I think they get more than full value for the time that is put in.

Another thing that seems very important in this connection is the fact that this gives a means for distributing throughout the country men with an intelligent appreciation of the needs and the problems of the War Department.

I think I read some time ago—something that was written before the war—where there was an allotment of $75—I am not sure that was the amount, but it was very small—$75 for investigating the effect of boat-tailing on artillery projectiles! It must be discouraging for men who are in the army to work under such conditions, because it is an impossibility to do anything with a problem of that sort, with $75 to spend. You might do $75 worth of guessing, but you could not do any shooting, so you would be no wiser than you were before you spent the allotment. If we had a large number of citizens who understood these problems and had an interest in them, it would make it possible for the war department to accomplish more. These men going into this work in the more or less formative stages of their lives would naturally think about these things, and they may bring out devices that are distinctly worth while. I think there are a great many problems in connection with getting the material, which require men with special knowledge, men who would devote years to some particular, rather limited problem. The army officers have not, as a class, a particularly good opportunity in that way, because they are put on one duty one day and another duty the next. I think the reserve officers have a rather better opportunity for that kind of development than the men who are in the regular army.

It may be interesting to remark incidentally—possibly most of you know—that for instance in the Coast Artillery Corps at the present time, the commissioned officers have a very large percentage of men who are graduates of the technical schools throughout the country, their technical training fits them very well for that work.

There is just one other point here that Mr. Parker spoke about, that is, the question of the students liking the work. My experience, as far as I have talked to students who have taken the work here this year, is that they seem to be well satisfied. They do like the work. I suppose in general it depends partly on the nature of the work and also on the particular officers who happen to be detailed to the institution.

Of course, we also have a certain number of students who do not like the idea of going to summer camps and being under military discipline. I personally think it is a good thing, and I rather think that the ones who do not like to be under military discipline would possibly profit the most by being put under it. I think perhaps they have had too much of the theory of the former professor here—I heard this story the other day—that he came home and saw a stream of water running out of his front porch. It seems his youngster had been upstairs and turned on the water, and let it go, and it was coming out the front hall and over the steps. The father held the theory that the boy must do as he pleased lest it would curb his initiative, but he was a little excited at the time, and the boy promptly put him right. He said, "Oh, John, don't raise a holler; if you don't like it, go up, and turn the water off."

P. F. Walker: The president has kindly given me an opportunity to talk a minute and a half on another topic. Since it will be impossible for me to stay after this session, I wish to make an observation merely. The president made reference to this being a comment from the point of view of the reserve officer. If I may be pardoned a personal reference, I went through the training course of the usual reserve officers' training establishment and served for a year and a half or so as a field officer with combat troops, in which connection I have had opportunity to view the work of quite a number of officers. Recently I was invited by the Chief of Engineers to go over the programs of work as laid out by the Committee on Training for the R. O. T. C. and make to him such suggestions as I might see fit, with a carte blanche to go ahead and say anything that I wished to say.

Now, briefly, I want to throw out this point. It has seemed to me that the committee on the relations with the War Department has been very polite, and has been very charitable with respect to the way in which the R. O. T. C. program work has been laid out. Those who have spoken on the subject here this afternoon have taken the position apparently that whatever is is, and, therefore, cannot be questioned. Now I have grown accustomed to look upon the War Department in a little more familiar manner, possibly, and I do not hesitate to say that there are some very glaring defects in the program of work laid out for the R. O. T. C. units. We need to consider this, I believe, because those persons who wish to see the officers training work carried through successfully, are, I know, interested to have it put on a basis that will enable it to survive, and my opinion is that the R. O. T. C. work cannot survive on the present basis. As I told the Chief of Engineers, it looks to me just as though the committee on training have taken our three months' program of training established in 1917 and 1918 and pulled it out like a rubber band, and made it so thin that it is not worth anything educationally. In other words, there has been lost the element of concentration which was apparent in those three months' training camps. We have lost the stimulus that came from the wartime condition, and there has been nothing of educational value put into the course of study land out for the R. O. T. C. that can commend it to the judgment of students or faculty people. I do not know how many of you have studied the program of work in detail, but to my mind, it is not only inadequate, but it is aside from the mark. I do not want to speak too forcefully on this matter, but I do feel that the jobbed up character of the work is going to kill it with reference to its being made a substantial and definite part of the work of students. Take, for instance, such matters as military courtesy, of signalling, the various other topics peculiar to the specific detail training of a man who is going into the military service. To have such work for a few hours in the first year, two or three hours more of it in the Sophomore year, and a few hours more given in the Junior year, is absurd. I feel that it is possible, if this society should see fit to take the matter up definitely with an offer to assist in the effort to put over a program that would be constructive and have real educational value, to do something that will contribute to the success of the work.

I have wished to present that viewpoint so that perhaps the record of this meeting would not appear to indicate that we were entirely satisfied with the R. O. T. C. programs, and that everything is going on smoothly. I really believe something should be done in order that that work be made a success.

REPORT OF COMMITTEE NO. 22 ON INTELLIGENCE TESTS.

This committee was appointed last June to determine the possible usefulness of intelligence tests and other objective tests for engineering students. We decided to answer this question empirically by conducting an experiment on a sufficiently extensive scale to justify definite conclusions. In the last analysis our problem is really one of vocational guidance in which we must determine the best methods of predicting vocational aptitude.

The plan of the experiment is briefly as follows. We collect considerable information about each student at the time of admission. This information includes such items as age, high school scholarship, high school principal's estimate, college entrance examinations, the special tests prepared for this investigation, and an intelligence examination. All of this information is tabulated and filed for safe keeping. When the students progress in their engineering course they will separate in ability. Some will drop out entirely, others will remain as mediocre students and others will excel. When we have their freshman scholarship available we compare these marks with each type of information that was available at the time of admission. In this way we are able to state the relative predictive value of each type of test with special reference to freshman scholarship.

In order to remove the personal equation as much as possible in the interpretation of our results we calculate the correlation coefficient for freshman scholarship and each test. If this coefficient is high, the test has predictive value; if it is low, the test is not useful for predicting freshman scholarship. Of course we must realize that freshman scholarship is by no means a final criterion of engineering ability. But we feel justified in using it until other more complete criteria become available.

The six tests that we devised for this investigation were as follows:

Test I contains a series of simple problems in arithmetic. All of these problems are intended to appeal especially to those boys who have been interested in things mechanical and electrical. We have tried to avoid problems that are stereotyped. This seems to be one of the best tests in the series.

Test II contains a series of simple problems in algebra. It does not differ noticeably from the ordinary algebra examination.

Test III is an examination in geometrical construction. It differs markedly from the usual examination in geometry in that the student is asked to solve a series of simple problems in geometrical construction by means of compass and ruler. No proofs are required.

Test IV is an intelligence test. It is in some respects similar to the Army Intelligence Examination but is keyed more difficult so as to be suitable for college freshmen.

Test V is a series of simple problems in physics in which some knowledge of physics is implied. The problems are so worded as to discourage mere repetition of memorized material.

Test VI is a test of general technical information. In this test we have avoided bookish items as far as possible and have emphasized those items of information which a high school student acquires of his own initiative in handling tools, making things, observing mechanical devices of common occurrence, and reading popular technical magazines. This test probably will not correlate as well as the other tests with freshman scholarship because the freshman courses are heavily loaded with mathematics and physics, and do not give any particular advantage to the student who has acquired extensive technical information by his own initiative.

This report of the committee is only a progress report with a few data as samples. The evaluation of the six tests from the 48 participating colleges involves so much clerical work that it has been impossible for us to complete the report in time for this meeting. However, I shall report on the findings for Ohio State University and Carnegie Institute. These findings are subject to some revision later when the data from all the colleges have been studied. The moneys collected from the participating colleges have been sufficient to pay not only for the printing of the test blanks, data sheets and blue print norms, but also for one full-time clerical assistant for the past school year. We have sufficient funds left for one clerical assistant through the summer months. By the efforts of Professor Bingham we have obtained through The National Research Council in Washington an additional allowance of $500 for clerical work. With this assistance we shall be able to evaluate the data from all the participating colleges during the present summer vacation.

We have now on hand 1,800 sets of examination papers which can be made good use of by colleges that desire to separate their freshmen in sections according to ability. These tests are available at the same rate as before, namely, $35 per hundred sets.

We have sent out 10,275 sets of test papers and we have reports for 7,069 students on these tests. These records represent 39 colleges that have reported to date.

We wish to emphasize the fact that in order to complete this experiment it is necessary to check up the test scores with reliable measures of engineering success. We now have measures of freshman scholarship. That is a good criterion as far as it goes. But we must continue to check up the tests with the same seven thousand students on their scholarship when they become sophomores, juniors, and seniors. We must also check up the test scores with their engineering success measured in various ways. Then we shall be able to say what kind of test should be given in advising a boy about taking up engineering as a life work.

RANK OF THE 38 COLLEGES IN THE SIX TESTS.

In examining this table we must not conclude that it indicates in any way the quality of instruction because the colleges are here ranked in order according to the scores made by their *entering* students. The table shows something, however, regarding the preparation and caliber of entering students in these institutions. The high rank of the two California colleges probably indicates the superior quality of high-school instruction in that state. The high rank of some colleges is probably due to the fact that they select for admission only one out of three or four applicants. This fact would tend to raise the standard of the entering class.

AVERAGE RANK OF THE 38 COLLEGES IN THE SIX TESTS.

2.5	Throop College of Tech.
3.5	Univ. of California
6.7	Cornell University
7.9	Worcester Poly. Institute
9.8	Case School of Applied Science
9.9	Rensselaer Poly. Institute
10.3	Syracuse University
12.3	Carnegie Inst. of Tech.
12.4	Ohio State University
13.7	Univ. of Michigan
15.2	Univ. of Pennsylvania
15.8	Tufts College
16.9	Michigan Agric. College
18.9	Univ. of Washington
19.6	Univ. of Kansas
19.8	Missouri School of Mines
19.8	Drexel Institute
19.9	New York University
20.7	Rose Poly. Institute
21.0	University of Virginia
21.4	Lafayette College
22.0	Univ. of Arkansas
22.5	Univ. of Oklahoma
23.0	Oklahoma Agric. College
23.2	Johns Hopkins Univ.
24.1	Univ. of Missouri
24.5	Kansas Agric. College
24.9	Rhode Island State College
25.0	Marquette University
25.2	Municipal Univ. of Akron
26.2	Vanderbilt University
26.5	Purdue University
26.8	Iowa State College
27.5	Trade School at Carnegie
27.5	University of Maine
28.0	University of Vermont
32.2	University of Alabama
35.1	New Mexico Agric. College

The ranks are obtained as follows: Throop College freshmen rank second in test I, third in test II, fourth in test III, fourth in test IV, first in test V, and first in Test VI. The average rank for the college is 2.5, as shown in the above table. Similarly for the freshmen of the other colleges.

COMPARISON OF PREDICTIVE VALUE OF HIGH-SCHOOL SCHOLARSHIP AND S. P. E. E. TESTS WITH SPECIAL REFERENCE TO FIRST-TERM FRESHMAN ENGINEERING SCHOLARSHIP.

Correlations between first-term scholarship and the following facts determined at the time of admission.

	Carnegie Institute.	Ohio State.
Algebra, Test II, S. P. E. E.	.41	.51
Algebra, High-school Grade	.39	.26
Geometry, Test III, S. P. E. E.	.41	.33
Geometry, High-school Grade	.23	.31
Physics, Test V, S. P. E. E.	.40	.39
Physics, High-school Grade	.24	.38
Average in Six Tests S. P. E. E.	.55	.65
Average High-school Scholarship	.29	.38
Thurstone Intelligence Test, IV (S. P. E. E.).	.37	.41
Army Alpha Intelligence Test	.34	.35

Comparison of the *Algebra Test II* and high-school scholarship in algebra shows that it is possible to predict the scholarship of an entering freshman better by means of a thirty-minute test in algebra than by his high-school scholarship in algebra in spite of the fact that the high school grade is supposed to represent a full year's acquaintance with the student's work in algebra.

The same type of comparison for the *Geometry Test III* and high-school scholarship in geometry shows similar results. One can predict a freshman's scholarship better by a thirty-minute test in geometrical construction than by his scholarship grade in high-school geometry. This may be due to the fact that the test was devoted exclusively to geometrical construction without proofs whereas the high-school course in geometry is too often limited to the memorizing of geometrical propositions and proofs. If instruction in geometry placed more emphasis on the solution of original problems in geometrical construction, the predictive value of the course with reference to engineering would be enhanced.

The same conclusion holds as regards *physics*. The correlations show that it is possible to predict freshman scholarship better by a thirty-minute test in physics than by the high-school grade in physics. This may be due to the fact that the physics test used in our investigation called for the application of principles in physics to simple problems whereas the high-school course does not emphasize the solution of problems in physics.

It is interesting to compare the predictive value of the *average score in the six tests* of this investigation and the average high-school scholarship. This shows that we know more about a student's ability to do freshman engineering work by the tests than by the average of all his high-school grades. In fact a single thirty-minute test tells more about what a student can and will do in his freshman engineering course than the average of all the high school subjects. This is shown objectively by the correlation coefficients.

It is also interesting to note the predictive value of the intelligence test alone as shown by the correlation between this test and first-term freshman scholarship. The coefficient for our thirty-minute intelligence test is .41 for Ohio State and .37 for Carnegie Institute. The corresponding coefficients for the Army Intelligence test show that the two tests are comparable as regards the prediction of first-term freshman scholarship. I believe examiners will perhaps agree that the cycle omnibus form of test which I have been using is easier to conduct than the separate time limits of the Army Alpha examination.

Age as a Criterion for Admission.

The accompanying chart shows the ratio of freshmen at different ages who withdraw during their freshman year. The withdrawals are fewest for the nineteen-year-olds and more frequent among the younger and older freshmen. These data are not conclusive and must be verified by the results from a larger number of freshmen at different colleges. These tables will be prepared this summer.

The Results for Withdrawn Students.

We have not only determined the correlation between the test scores and freshman scholarship but we have also tabulated separately the test scores of the students who withdrew during the first semester. The significant fact is that the lower the test scores the greater is the probability of withdrawal during the freshman year. The same condition is true to a lesser degree with high-school scholarship.

If an entering student at Ohio State in engineering has a high-school grade in algebra between 70 and 79 the probability is .21 that he will withdraw during the freshman year. If he has a high-school grade in algebra between 90 and 100 the probability is .16 that he will withdraw during the freshman year. This difference between .21 and .16 is not large enough to enable us to place much confidence in the high-school grade for predicting success in college work.

If a student makes a score in the half-hour test in algebra between zero and 3, the probability is .25 that he will withdraw during his freshman year. But if he makes a score of 9 or above, the probability is 0.00 that he will withdraw during the freshman year. In other words, one fourth of the students who make scores of 3 or less withdraw during the first year, whereas none of the students who make scores of 9 or above withdraw during the first year. Similar facts are shown by the charts for the other tests.

It *should not* be inferred from these statements that high-school grades are useless because the students who have high grades in high school tend to do better in college than those who earned low grades in high school. The fact that we have here discovered is that the half-hour examinations serve to predict freshman scholarship better than high-school grades.

Analysis of the correlations between freshman scholarship and each of the six tests shows that some of the tests have higher predictive value than others. The best prediction is obtained by the combination of the six tests. This is true both at Carnegie Institute and Ohio State University. That is to be expected. The freshman engineering curriculum is so heavily loaded with mathematics and physics that we should expect the mathematics tests to correlate best with freshman scholarship and such is the case. The algebra and arithmetic test correlate highest with first-term freshman scholarship. Next in order comes the intelligence test and the physics test. The test of general technical information has the lowest correlation (among the six tests) with first-term freshman scholarship. This is what we should expect, since the freshman courses do not give much advantage to the boy who has been interested in tools and things mechanical. However, I believe that when these tests come to be correlated with junior and senior scholarship and with professional success it will prove to have higher diagnostic value. The freshman enginering courses can be pursued successfully, by the boy who has no technical interests whatever since the courses are largely mathematical and analytical. Later in their course, however, the non-mechanically inclined students will find the engineering curriculum troublesome and that is the time when the predictive value of the test of technical interest and information will probably prove its value.

RECOMMENDATION.

That the committee be continued so that the results of sophomore, junior and senior scholarship may be used as criteria for determining the predictive value of the tests.

DISCUSSION.

A. A. Potter: Professor J. C. Peterson, of the department of education of the Kansas State Agricultural College, conducted the intelligence tests with 215 freshman students enrolled in the Division of Engineering at the Kansas State Agricultural College. The conclusions which follow are concerned mainly with 116 students' records which were complete with respect to high school grades, first semester college grades and intelligence test scores:

1. The test scores gave a much more accurate estimate of the students' achievement in college than did the high-school grades. Thus, in the case of the high-school grades, the students who ranked in the best quarter were only 6½ times as far above passing as those listed in the poorest quarter. On the other hand, the test scores gave the upper quarter 12½ times as good a rating as compared with those in the lowest quarter. The correlation between the test scores and college grades was .586 and that between the high-school grades and college grades was only .319.
2. The results show that a student who ranks, in accordance with the test scores, in the lowest quarter has a chance of 1 to 1 of failing in his college work.
3. The tests show that the students rated in the upper quarter failed in 2.4 per cent. of the work assigned; those in the second quarter in 8.6 per cent.; those in the third quarter in 15.8 per cent.; and those in the fourth quarter 26.8 per cent.
4. Students whose high-school records were complete made a much better showing in the intelligence tests than those who were conditioned in their high-school work.
5. The intelligence tests seem to show that this method can be used in controlling the assignments of freshmen students. Thus, the students who ranked in the upper quarter can carry three courses in mathematics and chemistry without difficulty. On the other hand, a student in the lowest quarter should not be assigned to more than one mathematical subject during any one semester.

While the results of this investigation are not conclusive, they do show that if intelligence tests are applied to the high-school graduates before they are allowed to enter college, the number of failures in the freshman year will be greatly reduced.

F. C. Caldwell: A certain skepticism about the completeness of the specification of a man as given by the grades of these tests is not uncommon. It fell to my lot to supervise the grading of the papers on general intelligence at the Ohio

State University, and it occurred to me to make a graphic study of the results.

The psychologists might not agree with me, but it appears that there are three causes that contribute to a man's failure to get a high grade in these papers. It may be that he is stupid, and that attempting the problems, he cannot solve them. It may be that he is careless, that he could do them if he was more careful, but he gets wrong answers. Thirdly, it may be that he is simply slow, he does what he does correctly, but does not have time to do them all. We might consider that the first two defects were of about equal importance. In other words, it would not be a very serious matter if we did not distinguish between the two, but almost every one would prefer a man, who, starting at the beginning of the examination, as in the case of one of these men, did 74 questions, and did 74 right, and then reached the end of his time, than a man who attempted many more questions, and still got a score of only 74. So the question to what extent this system of examinations does not take account of that difference seems to be a matter of some consequence.

Now, I plotted this curve, in which the grade is the ordinate, while the number of the last question attempted is the abscissa. Each point represents the score of one paper. So, for instance, we have here one man who did 75 questions and got a grade of 72; that is, there were 3 questions he failed on. Here is another man who also got a score of 72, but he attempted 150 questions. That is twice as many questions. We might say that the spread of the points along the horizontal line is a measure of the defects of this method of grading, regarded as a specification of the characteristics of a man. We would a good deal rather have the man who got 72 out of 75 that he tried, than the man who got 72 out of 150. If a man answers all the questions that he attempts, the point will lie on the 45° line. There was just one man who did that, every other man lies quite a little below that line. There are also shown lines whose tangents are sixty, seventy, eighty, and ninety per cent. Nearly all the points lie between the lines for about 76 per cent. and 94 per cent. If this method of grading is justified, it would appear to be because so large a majority of the points lie within a comparatively narrow range. On the other hand, there is a considerable scattering of points on both sides that vary quite widely from that range. So that it may be that instead of giving this specification as simply the one number, which is now given as the grade, there ought to be a complex number made up of the present grade, and a ratio of the number that he answers correctly to the number that he attempts. So that in the case considered above, you would have a complex grade of 72–96. Seventy-two is the number of answers; 96 is the ratio of that number to the number that he attempted. Whereas the man who having attempted 150, also has a grade of 72, would have a grade of 92–48. We might say 72–96 represented a good deal better type of man than 72–48.

Professor Magruder exhibited a chart, showing the correlation of the summation of the three mathematical subjects of the S. P. E. E. Intelligence Tests with the results of the first semester's examination in mathematics at The Ohio State University and the slight probability of the man who made a high score in the former failing in the latter.

He showed blueprints giving the relations of the high school students to their grades, or numerical marks, as sent in to the Entrance Board, and showing the extremely high grades given by high school teachers to their students who came to the university, only seventeen marks out of 2,500 being below 70 per cent.

Another blueprint showed graphically that, according to the results of the examinations, the 625 students who were tested had much more intelligence than they had knowledge of algebra.

Another blueprint showed the very great similarity of the results reported by the departments of chemistry and mathematics for over six hundred students in their work of the first semester.

He stated that the results so far obtained seemed to give predictive values that could be used wisely by deans and presidents in advising and guiding students who needed to be urged to do better work because they had shown themselves to be capable, and those who should be advised to give up the study of engineering for lack of vocational aptitude, also, that poor preparation and other handicaps could be overcome by diligent study of the intelligent student.

Prof. Thomas: Mr. Chairman, I wanted to say that during the last two or three weeks we have been studying the intelligence tests given at Rose Polytechnic Institute for the purpose of determining for our own satisfaction whether these tests ought to be applied to the entering freshmen at the school. I have to confess that the results are a little disappointing. The tests are good, but they are not the success

It seems to me then that although the tests show up very nicely with the averages Professor Thurstone got, but there seems to be quite a sprinkling of individual cases in which injustice would have been done by applying those tests too rigidly.

Out of a class of ninety-six Freshmen, fifteen men were dropped from school for poor scholarship. We studied the records in various ways, and among them the way Professor Thurstone used of grading the men according to the S. P. E. E. fitness test, and dividing the class into upper quarter, second quarter, third quarter, and lower quarter. We found that in the upper quarter not a man was dropped for poor scholarship. In the second quarter, two men were dropped; in the third quarter five, and in the last quarter eight. Now it looks from this as if the tests were very perfect, but on closer thought we examined the seven men who failed in the fitness test and yet did very well in the Freshmen year, and we found that in every case those men were of a good type, slow but steady. If we had applied the fitness test to them strictly, they would have dropped out, and never had a chance to go ahead. For example, the very last man in the class in the fitness test was well up in the upper half of the class in freshman work. Also the man who was the very highest of the class in second term freshman work, with an average of 91, was very low in the fitness test. This man is a reliable but rather slow fellow, and it looked to me as if the newness of the tests staggered him. I am satisfied that of the seven men who would have failed by those tests, nearly every one corresponds to this type.

It seems to me then that although the tests show up very well in general averages, and they make very nice curves, they are very likely to lead to injustice if applied too strictly. They are a good thing, but they ought to be combined with other kinds of tests, and they ought not to be given too great weight as an entrance criterion. The old type of entrance examination seems to give a better opportunity for the fellow who is slow and steady. It is by feeling that ordinary examinations should be combined with the fitness tests, and the fitness tests given the weight of not more than a third to a fifth of the whole entrance criterion.

REPORT OF THE COMMITTEE ON DEGREES.

The committee has not been able to meet, and has maintained communication by correspondence.

The committee decided to confine its attention to the preceding reports of similar S. P. E. E. committees; and in particular to

(1) The Report of the Committee on Engineering Degrees adopted at the Madison meeting and printed in Vol. XVIII of the S. P. E. E. PROCEEDINGS, 1910, pages 135–156. This is called the first report.
(2) The Majority Report of the Committee on Engineering Degrees presented to the Evanston Meeting, and printed in Vol. XXVI of the S. P. E. E. PROCEEDINGS, 1918, pages 177–179. This is called the second report.
(3) The Minority Report of the last above named, pages 184–185. This is called the third report.

The committee, in general, endorses the first report; but is unable to reach unanimity on all of its clauses. The reservations, made by the individual members of our committee, particularly relate to Clauses I and VI (pages 149–150, Vol. XVIII).

In regard to Clause I, some of our members endorse the third report.

In regard to Clause VI, there is considerable dissent from the plan of awarding the degrees of C.E., M.E., etc., for professional work not executed in residence.

Although our committee has not been able to reach unanimous opinions on the above points, we recommend the standardization of degrees given in engineering by the various American colleges, as far as may be practicable.

Respectfully submitted,

C. L. Cory,
C. T. Morris,
Harold Pender,
P. F. Walker,
F. L. Pryor,
C. F. Scott,
F. W. Sperr,
A. E. Kennelly, *Chairman.*

Discussion.

F. W. Sperr: I am sorry Professor Kennelly is not here to present this himself. It is very brief, but I think what the committee wants, what Professor Kennelly wants, is a discussion on the part of the society in order to see whether it may not be possible to arrive at some uniform custom or manner of giving engineering degrees. The Chairman of the Committee submitted a number of propositions to the members of the Committee, and the main question that we had to decide as members of the committee was whether we were to take up an entirely new line of work or consider the reports of past committees on the same subject, and the consensus of opinion, I believe, was that we should devote ourselves to the reports that had already been made, to see whether we could not bring harmony out of what had already been done, but with rather conflicting and adverse results.

I do not need to read this whole paper. You have it before you. You can see all there is at a glance, but I wish especially to call your attention to the last paragraph there, "Although our committee has not been able to reach unanimous opinion on the above point, we recommend the standardization of degrees given in engineering by the various American colleges, as far as may be practicable."

I think likely every one in this society will be agreed on that proposition, but just how that should be done, we will, of course, have varying opinions. With regard to that reference, he says some of our members endorse the third report, and I have a copy of that report here if anyone should want to see it. You remember perhaps that the majority report recommended the terms of bachelor of science in mechanical engineering, civil engineering, in electrical engineering, and so forth, while the third report recommended the giving of the degree of civil engineering, mining engineering, electrical engineering, and so forth, without any qualifying phrases. The committee has had no opportunity to meet and discuss the subject, but I believe personally that the time for the necessity of such a qualifying phrase as bachelor of science in these various kinds of engineering has gone by. In the earlier days of engineering education, the general public knew little or nothing of what the engineering course comprised, or included, and there was an attempt made on the part of the educators to indicate on the diploma that it was substantially a bachelor of science degree, supplemented or strengthened by certain lines of work which qualified the man for the pursuit of some engineering profession. I believe it started with civil engineering, and I am not sure whether mining engineering came next, and then mechanical engineering, and various other kinds of engineering, and there were other influences, no doubt, that contributed to the rather general practice that was inaugurated of making the degree read Bachelor of Science in. I believe the quality of American engineering education is now well known the world over, and it is no longer necessary to explain it by any qualifying phrases on the graduate's diploma. And, moreover, the successful completion of an engineering curriculum is well worthy of a pride and satisfaction that should be recognized on the diploma, and I know of no better way to accord such recognition than by the simple letters C.E., M.E., E.E., E.M., Ag.E., etc. It further appears from Professor King's paper on Engineering Degrees in Latin-America Republics that our neighbors to the south understand what the degree of mining engineering and mechanical engineering means just as we understand it, but they do not understand the term Bachelor of Science as we understand it. If there is an advantage in becoming better understood by our neighbors to the south, and I think there is a decided advantage, I am one of those who favors the third report without qualifications.

W. G. Raymond: Mr. Chairman, I don't believe that it is necessary to discuss the report because I suspect that the last clause says about all we shall ever attempt to do or ever succeed in doing, and yet I would like to present a scheme we have with us because I think it is rather logical. We call our four-year men, when they graduate, Bachelors of Engineering, no matter in what course they have been. They are not Bachelors of Science, although they have been students in the school of Applied Science. We call them Bachelors of Engineering. That leads the way to a professional degree. That professional degree of civil engineering, mechanical engineer, or chemical engineer, is obtained after four years of active practice, one of which mustbe in responsible charge, and one may be a year in a University, a year of graduate study. We have tried to make the one year of graduate study count as two of actual practice, and we think that is logical, because that permits us to give a man a professional degree as soon as he would obtain associate membership in the American Society of Civil Engineers, or practically the same rank in the other societies. So we recognize him as a full engineer with full title when he would be recognized as a member of one of the national societies. We do not require him to make a thesis or anything of that sort. We do require him to submit names of persons to whom we write for information as to the character of the work he has done, whether or not it is of sufficient importance to warrant giving the degree, and sometimes we do not give it at the end of four years. Giving the general degree of Bachelor of Engineering permits also, without straining the point, to give the man who studied in civil engineering but practices in electrial engineering, the degree of electrical engineer. We have given the degrees of electrical engineer and civil engineer to gradates of mechanical engineering, and the degree of mechanical engineer to graduates in electrical engineering. We think that whole procedure is quite logical, but so far it does not seem to meet with great favor in this organization.

F. C. Caldwell: Mr. Chairman, we give the degree of Bachelor of Electrical Engineering at The Ohio State University, but I was very much pleased to hear what Dean Raymond says. It would seem most desirable to get together on a single engineering degree. It would then become generally known in the same way that the degree of Bachelor of Science or the Degree of Bachelor of Arts is known, and also would have a further advantage in emphasizing that we are primarily engineers, a fact that is coming to be more and more appreciated.

Dean Raymond: No, sir, two years, one in responsible charge. This putting one year in graduate work equivalent to two years in practice arose out of the difficulty we got into when it came to dealing with the men who were taking the five years' chemical engineering course. They rather wanted a degree at the end of the four years, and we did not quite know what to do. We give them the degree of Bachelor of Science, B.S., at the end of four years and then they must stay another year. Then they get a certificate only. After two years if one year has been in responsible charge, they get the degree of chemical engineer.

Professor Sperr: I do not think it is so much a question of what we require, but of what we show in the degree.

Professor Thompson: I would like to ask the chairman of the Committee, if I may, just one question. That is, if the engineering societies have expressed any opinion as to what name should be given or what the title of the graduate into the various engineering degrees should be? I think perhaps there is one place we might get into a little coöperation with them, to find what practicing engineers think about it.

Professor Sperr: I cannot recall at this moment, but it seems to me in one of these papers in the same volume I referred to before, something is said about that, but I think it should be thoroughly determined to see what the societies of the various engineering bodies think about the matter, and what in their experience would seem to be best, but isn't it also true that each member would think that the degree which has been given should be the one to be continued?

Professor Thompson: Have those organizations no committees on Engineering Education or any committees that are in any way coöperating with this society? It seems to me there is a question on which we should be able to get some formal expression from those societies, not necessarily from the individual members.

ANNUAL DINNER.

Dean Cooley: It is my present duty as senior host to the members of the Society for the Promotion of Engineering Education to introduce to you or present to you the president of the society, who will now deliver his annual address. President Greene.

President Greene: Dean Cooley, ladies and gentlemen: Before reading my address to you, I wish to take this opportunity to give my thanks and my appreciation to the members of the Council, to the secretary, the treasurer, and the secretary's assistant, for the work with which they have aided me during the past year. I personally have enjoyed this meeting very much. I think it has been a good meeting, but I do not think it is due to the President. I think it is due to the officers of the Society and the committee here in Ann Arbor, and I wish at this time to make my public acknowledgment.

President Greene: Ladies and gentlemen: A number of years ago Professor Sprangler, of whom I spoke at the opening session of this convention, prepared a small paper in which he gave information of the Mechanical Engineering Department of the University of Pennsylvania to the graduates. That paper was intended to keep Sprangler's boys connected with the old home. I think for a mechanical engineer he chose a very happy title for this small four page sheet. It was called "The Connecting Rod." It appealed to the mechanical engineer, and it did join the cranks with the crosshead.

So much for the application to Pennsylvania. The crank and the crosshead now assist each other. We have, however, in our society, a connecting rod between one administration at the University of Michigan and another. Rarely does a society have the distinct honor of being welcomed at its opening session by one president of a University, and also, if I may use the term, Mr. President, welcoming a new president. That is our distinct honor. We form the connecting link between President Hutchins and President Burton. The society is very anxious to extend at the close of the first day of the new presidency its felicitations and best wishes to you, sir, and they have asked me if I could present, before I called on you to speak, a small token which may wither, but which expresses thoughts which will never die. With the best wishes of the society (presenting flowers to Dr. Burton) I present these flowers, and will call on you as the next speaker. President Burton.

WHAT MUST THE COLLEGES DO?

BY M. L. BURTON,

President of the University of Michigan.

America has always believed in education. Before the war there was ample evidence that Americans had great confidence in institutions of higher learning. The large sums of money provided by private gifts and by legislative appropriations were concrete proof that this country was fully aware of the value of higher training. Since the war it is perfectly evident that America has a passion for education. The unprecedented enrollment of students this fall in colleges and universities may be attributed to the war. Multitudes of men have seen in the army that opportunities for leadership frequently go to the trained man. The people as a whole have observed that education and democracy are inseparable. Along with this splendid new passion for education has come a tendency on the part of large numbers of discriminating people to scrutinize with care, and in some cases to criticize with severity the aims, methods and results of our entire educational system.

We should lack in candor if we did not recognize frankly the present situation of the liberal arts college. In various sections of the country the Junior College plan is being promoted and is developing with considerable rapidity. It fosters the tendency for a boy to remain at home for the first two years of his college work and then to go directly to his professional training. This plan in a comprehensive system of state education aims to relieve the large state universities of the serious overcrowding of the freshman and sophomore years. Closely connected with this proposal is the demand for a complete reorganization and regrouping of the units of our educational system. Beyond, or within, these considerations is the whole problem of the economy of time in education calling for the elimination of two years in the primary grades, one year in high school and such a readjustment of pro-professional training that a student may reach at an earlier age the specific field of study which is to prepare him for his life work. Without doubt the heart of the issue concerns the student's attitude to his work. The boy in the liberal arts college is accused of "general aimlessness." He suffers by comparison with the professional or technical student whose definite aim gives a seriousness and earnestness to his work. Through all of these considerations runs the vague but certain assumption that this new day demands something new of the college. All of these factors combine to produce a total situation which leads many seriously to consider the future of the college of liberal arts.

Certain preliminary observations may be made at this juncture. The traditional answers to our question will not suffice. The colleges must teach and must foster investigation but the present situation will not be met by the mere reiteration of those formulæ. On the other hand, the colleges have stood for too much truth in the past now to be destroyed or even to experience a complete metamorphosis. No disagreement need arise in regard to the primary importance of research. The differences in this respect between a college and a university must not be overlooked. But even so, it may be said with some show of wisdom that no man can be a virile and stimulating teacher *over a long period of years* unless he is thoroughly at home in his field and giving occasional evidence of his eagerness and ability to make some contribution to the world's mastery of that field. So with no undue straining after something new, but with a profound conviction that the present situation demands a new emphasis upon certain phases of college work we set out to suggest an answer to the question "What Must the Colleges Do?"

The college must place a new strong emphasis upon the old-fashioned demand for accuracy. The facts involved here are so familiar and so obvious that they need not be set forth in detail. Speaking historically, we have been a race of pioneers. From the beginning we have done the best we could. No one has pretended that we were doing as well as we should like. It takes time to develop a substantial, enduring civilization. It is frequently charged that superficiality is an American vice and no one thinks of denying the accusation. The inevitable results appear in everything we try to do. In art, in architecture, in literature and in education it is possible to find ample evidence to sustain this point of view. Temperamentally we are not well equipped for patient work. We are in such a hurry that we haven't time to recognize its evil effects. The complexity of our life is increasingly astounding. We rarely settle down with the single aim to do a job the way it should be done. These tendencies have affected our standards. Our aim is to turn off the task. Our ambition is to see how quickly a thing can be done. It sometimes seems that our chief thought is centered not about doing something, but merely appearing to do it. In many of our common activities, notably in politics, we have developed persons who are masters in passing responsibilities to others. It is not surprising that these tendencies and qualities have manifested themselves in American education. Our educational institutions inevitably reflect the spirit of our civilization. A decade ago, the attack upon our colleges was bitter. In many respects the accusations were entirely justified. America's hurry and superficiality found one form of expression in the typical undergraduate who had little concern for the real work of the college. On the other hand, we have a right to expect that some of the best products of American colleges would appear among the Rhodes Scholars. There are many qualifications to such a statement and many extenuating circumstances which might be cited, but the Rhodes Scholars of the last ten years have certainly been above the average of the men produced by our entire educational system. It is interesting, therefore, to know how these men have impressed their Oxford tutors. In general, Oxford has recognized generously and sympathetically the good qualities of the American scholar. But his educational equipment has not been eulogized. Among large numbers of published statements one finds such expressions as these: "They seem very deficient in scholarship in a wide sense." 'They seldom or never settle down to a long spell of thorough work." "They have been taught nothing very precisely." These are serious and severe indictments not only of a few Rhodes scholars, but of American educational standards as a whole.

Fortunately, the war has established a whole set of new facts. America has emerged from the conflict with a new sense of thoroughness. We have seen our waste and extravagance in their true light. We learned, under necessity, how to bring to bear all our resources upon a common problem. Almost over night, we discovered how we could do something when we really wanted it done. The mobilization of our financial and industrial strength was magnificent. We did the job thoroughly. The war itself has produced excellent results in the students. While many of the men are physically restless, and while regular courses have been interrupted and normal procedure in their educational career disrupted, they come back with a new spirit. Many of the specific duties of army life have intensified the demand for real accuracy. They actually see now why accuracy is a prerequisite of all worthy effort. Perhaps nothing could have engendered this new point of view except the frightful necessities of war. These men are more mature than any students we have known. They have been face to face with the sternest realities of life. They understand now what the world expects of them. Even before the war a new sense of intellectual seriousness was developing in the colleges. Running all through our national life is a new emphatic note of obligation. The colleges must seize this occasion to drive home in a new day the old demand for accuracy.

It may be valuable here to look more carefully at this quality. It obviously is derived from *ad* and *curare* and therefore connotes carefulness, preciseness, exactness and definiteness. Speaking negatively it calls for the absence of defects, the elimination of mistakes and freedom from errors. From the positive point of view it calls for exact conformity to a standard or to truth. It inevitably requires delicacy, nicety, precision and fineness of thought and action. There is something about it which insists upon the quality of "rigor and vigor." Practically it demands of the student that he make some definite and final choices out of the superabundance of riches which college life hurls at him. It says that not by a hap-hazard, ill-considered jumbling of all of the elements of undergraduate life but by concentrating completely upon a few of them, will he save his soul. It suggests to him that he settle down to the task in hand. It hints at patience and thoroughgoing effort. It proclaims the stern doctrine that there is high value in hard work. It is the old-fashioned, insistent demand lying back of all worthy effort in any field. The colleges of liberal arts have said much about culture. It may be valuable to insist here that accuracy and culture are inseparable. Professor John Dewey spoke wisely when he said that "there is perhaps no better definition of culture than that it is the capacity for constantly expanding in range and accuracy one's perception of meanings."

But how shall the colleges perform this function? It is at this point that serious disagreement will arise. Some will insist that the demand for accuracy is only another way of advocating a renaissance of classical study. Others will find here a defense of mathematics and scientific subjects. No doubt there are large elements of truth in these contentions. The outstanding fact, however, which we must not fail to recognize, is that accuracy does not depend upon the specific content of this or that course of study. It is not, I take it, primarily a question of curricula or their organization with which we are dealing. It is rigid discipline in all subjects that we must have. The duty of the liberal arts college is to "cultivate the fundamentals." No one can pretend to have sufficient wisdom to anticipate the specific issues of the day in which the present generation of students will do its work. Therefore the prime consideration is not the pursuing of this or that subject, but the acquiring of a highly sharpened tool which will cut its way straight through the twisted materials of a rudely shaken social order. If the colleges can send out men who will instinctively demand the facts, and who will constantly insist upon wise and timely legislation in keeping with those facts their service to the country will be quickly recognized and highly appraised. The colleges of liberal arts will have a right to exist if they produce a generation of citizens trained to work thoroughly and patiently and to think cogently and accurately.

The college must stimulate and awaken its students. Any careful student of American education recognizes that a very significant change is coming over some of our institutions of higher learning. A decade ago, the first consideration was research. The teacher was quietly disregarded for the man who could "produce." To-day the teacher is coming into his own. This tendency does not mean that investigation has fallen or is to fall into disrepute. Research will always be of primary importance to a true university. But it does mean that colleges are frankly recognizing their obvious obligations to students.

The assertion that colleges must awaken their students will arouse the concern, if not the opposition, of three groups of people. The technician desires to emphasize the acquisition of some particular skill or dexterity. Surely there need be no essential disagreement at this point. The advocate of vocational education or the defender of professional training seems to surpass others in stimulating his students. The investigator insists that contributions to knowledge are his first, if not his only, concern. Again there is no possible incompatibility between the two points of view. There are some, however, who, conceding their good taste look down with disdain upon "inspiration." They are highly to be commended, if by inspiration they mean mere excitement, shallow emotionalism or flitting enthusiasm. They are utterly mistaken if inspiration means the awakening of a human being to some appreciation and realization of the meaning of life.

The demand that our colleges awaken their students is grounded in some very serious facts. The externality, mechanism and formalism of American education are notorious. Consider for a moment our prevailing methods for admission. Think how we have counted units, hours and minutes! If a boy has had fifteen units he has been admitted and if he has had fourteen we have said that he is not "college material." The rapidly changing plans for entrance are clear indications that we have revolted against some of the methods prevailing in the past. Our system of examinations within colleges are scarcely intended to encourage the habit of becoming thoroughly at home in any given field of knowledge. A student at the end of the first semester takes a set of examinations and, if he passes, the grades are piled away like so much wood that has been sawed. He repeats the process eight times and we call him "educated." The multiplicity of rules, regulations and statutes produce a wholesome effect upon the freshmen, if bewilderment is good for the soul of a new matriculant. The spirit of the average class room is rarely intended to arouse students to new levels of thought and action. Doubtless if Henry Adams were teaching in any first class American college to-day, he would say just what he did of his students at Harvard College. "All were respectable, and in seven years of contact, Adams never had causes to complain of one; but nine minds in ten take polish passively like a hard surface; only the tenth sensibly reacts."

We need not, however, rest the case here. This generation of students faces prodigious tasks not only of national but world wide proportions. Mr. Frank Vanderlip's book entitled "What Happened to Europe" suggests the magnitude of the gigantic work that must be done. Huge war debts, the demoralization of transportation, the disruption of industrial processes, the disorganization of life as a whole, have created a world situation which calls for all of the skill and ability which America can produce. Back of these considerations, is the fascinating, challenging fact that the present generation of students has almost unlimited potentialities for coping with these momentous tasks. These potentialities must be utilized. The colleges simply must awaken their students to new comprehensions of the possibilities just ahead. The achievements of our armies in this war substantiate the assertion that marvelous capacities lie dormant in American youth awaiting only the stimulus of a great cause and a great occasion.

The Century Dictionary says that ''stimulate'' means to ''animate to action or more vigorous exertion by some effective motive.'' Surely the motive exists. Physicians sometimes speak of ''stimulating baths.'' The colleges must surround the student with a quickening, thrilling environment. It can only be done by the contact of spirit with spirit. The world still responds to the quickening touch of a great soul.

If the colleges are to stimulate their students certain requirements must be met. First of all, Boards of Trustees, and college administrations must place a higher evaluation upon the art of teaching. Concretely, the salaries of professors must be advanced at once to the point where mere self-respect is possible. And *then* we must have teachers who teach. That is to say, we must have persons who actually proceed upon the hypothesis that the thing which counts in the classroom is not the amount of material which is presented but the actual, positive awakening of a human being to some faint understanding of the responsibility of being alive. Let us hope that then we may have students who study. That is to say, young men who without losing the respect of their colleagues can show actual concern for their understanding of truth and their interpretation of life.

The plea we make is for the simple recognition of the commonly accepted truths of educational psychology. In his work entitled "Education and Democracy" (page 46) Professor John Dewey has expressed it this way. "That education is not an affair of 'telling and being told' but an active constructive process, is a principle almost as generally violated in practice as it is conceded in theory." By some method the college of liberal arts must stab its students broad awake. The present hour will tolerate no other result. Emerson preached the same idea most eloquently. He insisted that "the one thing in the world, of value, is the active soul. This every man is entitled to, this every man contains within him, although in almost all men obstructed, and as yet unborn." Here is the tragedy of education. Henry Adams knew full well that only one mind in ten sensibly reacts to the presentation of truth. It is the fascinating, divine task of the college of liberal arts to remove the obstructions and to demolish the obstacles which stand in the way of every man possessing an active soul. As Carlyle would say "in one way or the other it will have to be done." We shall have to pull down the brute god, Mammon, and put a spirit God in his place!

Again the colleges must reckon seriously with the present. The student must be made to live in the new day. Students have acquired accuracy and their spirits have been thoroughly aroused by the study of Sanskrit. These results are obtainable by the use of many disciplines dealing with the past. Mankind, however, has just emerged from the most direful cataclysm it has ever experienced. The country will demand of the colleges, and rightly so, that the students be thoroughly at home in their own day.

By some method, the college man must come to understand, the great movements of the present day. The war has placed great burdens upon mankind everywhere. Marvelous new forces have been liberated. Strange and mysterious movements have been inaugurated. Great outstanding issues must be met and extremely intricate and complicated problems must be solved. The facts are not at hand. Moreover, the facts, particularly in all the social sciences, are not dead, rigid, static things which can be tabulated. They never congeal. The situation to-morrow will be different from what it is to-day. Consequently students cannot be sent forth with readymade opinions. They must, however, become aware of our situation and feel at home in dealing with these gigantic questions. They can acquire a background upon which sound and substantial judgments can be formed as the facts develop and the tendencies of their day become discernible.

For example, every discriminating citizen for decades to come must have some real knowledge of international law and the whole field of international relationships. The ratification of the peace treaty, while important, will only mark the beginning of a new era in world relationship which will call constantly for wise and statesmanlike action. Or again, the whole problem of our industrial relationships must be worked out in the years just ahead. The great questions of "representation in industry," of collective bargaining and the rights of the public will demand the most patient and careful reasoning. Mr. Albert Mansbridge, writing in *The Atlantic* for August, solemnly asserts that "no community can afford to let the powerful forces of education and labor develop otherwise than in conscious coöperation." Every citizen must understand the labor movement. Beyond these highly important subjects lies the crucial question of the hour. All about us are groups who insist that the ballot box is too slow in producing results, and that we shall never achieve social progress by the regular constituted agencies of the government. Therefore, they appeal to the direct method of violence, revolution and destruction. The issue now is quite similar to the one which Abraham Lincoln faced in 1861 only it is upon a far wider scale and more subtle and insidious in its operations. Mr. Lincoln raised seriously the question whether all republican forms of government have this inherent weakness: Must they be too strong for the liberties of their people or too weak to maintain their own existence? That certain groups believe the first and hope for the second cannot be questioned. College men of to-day should be compelled to think clearly and decisively upon this paramount issue. Unless democracy can insist upon an unqualified, unconquerable respect for law and order, then only disaster is ahead.

Doubtless there will be little difference of opinion concerning the end to be attained but there will be serious disagreement as to the methods to be employed in seeking that end. It goes without saying, that we must be prepared in our colleges of liberal arts to offer excellent and thorough training in all the social sciences. If a man gets a thorough grounding in history and some real understanding of political economy, political science, and sociology he will surely be ready in a measure to cope with the main movements of his day. Likewise, modern languages will be increasingly essential for the man who is to acquire a real understanding of world tendencies.

The vital necessity, however, is an atmosphere of cogent discussion. Every classroom must be a place where mind meets mind, where there is little, if any, appeal to external authority, and where there is much devotion to clear sequacious thinking. A real college will be a place where members of the faculty and students, with mutual respect for each other's opinions, will associate in perfectly natural and normal ways and exchange views upon the developing life of the world. Perhaps the highest test which a college has to meet, is whether its students actually discuss among themselves their serious intellectual interests. If an atmosphere could prevail where a student could retain the respect of his colleagues and still raise with them in groups, large or small, his intellectual difficulties, then our problem would be largely solved. Every college should have a public forum, where the vital issues of the day are faced with frankness and candor. To achieve recognition here should be the highest distinction open to a student. By some such method, and under the guidance of some such motive, unlimited possibilities for greater effectiveness in college training lie before us. However it is done, we must have students who understand their own day. The facts are so elusive, the conditions are so fluctuating, and the ramifications of our problems are so extensive, that prolonged, careful thought is absolutely essential. Students must acquire a habit of mind which will serve them faithfully in the actual conflicts of the world. Such mental equipment Bacon must have had in mind when he said: "Read not to contradict and confute, nor to believe and take for granted, nor to find talk and discourse, but to weigh and consider."

The colleges must inculcate integrity. This is a strange utterance. It involves no accusation of the colleges and is not intended to establish the inference that dishonesty has characterized our work. Nor is it intended to contradict the Socratic doctrine that knowledge is virtue. No doubt, any one who really understands life is a man of integrity. At any rate this seemed to be true until the war revealed to us the real motives and character of the representatives of the Imperial Government. Prior to that time we may have believed that there was no such thing as an "educated villian"! Now we face a situation which tests the consistency of our thought. Emerson was entirely correct in reminding us that "consistency is the hobgoblin of little minds." However we may state the matter in terms of logic or philosophy our colleges must be places where men are marked by plain honesty and sheer integrity.

The world situation to-day accentuates if it does not originate this demand. The war destroyed confidence everywhere. Mutual understanding and good-will between all groups within our country and between all nations is the primary need of the hour. But confidence can be established only on the basis of character and integrity. A very serious situation for the colleges arises out of the fact that all the world knows the part German education played in fashioning German ideals and motives. All mankind disapproves morally and spiritually of Germany. Our people trace the causes directly to a false educational system. It is not surprising, therefore, that our country is watching with considerable care, if not suspicion, the actual operation of our entire educational system. The unescapable lesson of the war is that Germany lacked in integrity—plain, sheer uprightness. The duplicity and mendacity of her diplomatic representatives combined with her repeated efforts to eliminate all ethical considerations from international relationships sustain this statement beyond all danger of successful contradiction. At the present moment, all nations and all mankind trust America. Just so America must be able to trust her colleges and her educational system as a whole.

Our institutions of higher learning, therefore, must be synonyms for integrity. To-day as never before the college of liberal arts must stand for absolute, unqualified devotion to the truth. In all of the complicated relationships of a new day when vital issues are at stake, all groups and all interests must understand that the colleges will teach the truth regardless of the consequences to their endowments, their enrollments and their equipment. No man must be permitted to suggest that a muzzle be put on a college professor so long as he lives in keeping with the normally accepted moral standards of the community and is a loyal defender of the constitution and government of the United States. In spite of the effects upon himself, his job, his family and his future, the true professor, in sheer self-respect, must know that he can teach the truth as he sees it.

The whole institution must be saturated with this spirit and point of view. Honest work must be done in every classroom by every student. There should prevail everywhere the general, unquestioned assumption that every person instinctively maintains a standard which requires the finest type of honesty in every collegiate relationship.

The extremely difficult and highly significant phase of this truth, however, is not only that the college should be honest but should be accepted and recognized as honest by the people.

Therefore, we must avoid all appearance of evil. We must keep our hands clean. There must be no smell of smoke on our garments. We must be able to put into the world men who will instinctively and incessantly oppose all forms of social evil and who will coöperate with every good movement looking to the welfare of the people as a whole. It will not always produce agreeable results. Righteousness occasions much discomfort for large groups of people. The trained citizen of to-morrow will actively oppose the business man who profiteers, the laboring man who shirks, the politician who sets private gain above public weal, the citizen who selfishly enjoys the blessings of democracy without meeting its demands and the man of means who fails to accept his wealth as a social trust. He will recognize that truth knows no time distinctions, that policies and principles are not true or false because they are old or new. Therefore, he will attack both the radical who forgets the wisdom of the past and dreams of an impossible future and the conservative who idealizes the past and neglects the plain duties of the present.

These are critical days for the college of liberal arts. Obviously there is more need for it to-day than ever before. It simply must function mightily in the midst of marvelously fascinating conditions. Its future is secure if, even in a measure, it can train students to work thoroughly and to think accurately, if it can awaken men to some realizing sense of the meaning and glory of being alive, if it can enable students to know their own day and above all if it can make them men of integrity.

These are not new duties. They are the old demands accentuated by the needs of a new day.

Discussion.

Dr. Hutchins: For several years I have been accustomed to surprises. Of course, I have taken it as a part of my life, part of my experience, that I should be called upon to say something without having had an opportunity for preparation, at all sorts of gatherings. When a college president was about to be inaugurated, President Butler, of Columbia, sent him word that the first qualification that he must possess was the ability which would enable him to speak three hundred and sixty-five times each year without the slightest preparation.

It is not a pleasure for me to say the parting word. It is pleasanter to say the welcoming word. I tried to say that the other day. I trust that your stay of a few days among us has not been without profit and pleasure. I wish to assure you—I think I can do that, although I am no longer President of the University.

Dr. Burton: Anything that you say goes.

Dr. Hutchins: I wish to assure you that a most cordial welcome will await you in the future whenever it shall be your desire to return to Ann Arbor. To use a New England expression, remember, please, that the latch-string here is always out.

President Greene: About two years ago I visited Detroit with Mr. Calvin W. Rice, of the American Society of Mechanical Engineers, to meet with their local section in that city. There were a great number of Michigan men there. They greeted the president of our society as an old friend, as almost a father, and in return he gave that smile which I have been told the Governor of this State once said would cause the wolves to go away. I could easily see then how they loved their dean, their professor, Dean M. E. Cooley.

I was reminded to-night of a little girl here in Ann Arbor who once asked her mother whether Mortimer was a name or a title.

I think we are very fortunate in having this man for our next president, and I am gratified in having the honor to turn over the affairs of the society to him for the coming year. President Cooley.

President Cooley: I accept the responsibility of the Presidency with some anxiety. Such a splendid example has been set during the past year for the new president to follow that I fear he will often find himself at a loss how best to proceed. But I have been greatly inspired during these past few days. It has been impressed upon me that you are a body of thinking men; also that you are very prolific. No difficulty should arise in the preparation of a program for an annual convention. The difficulty, as I see it, will be to eliminate great masses of material that will be presented. Our Ex-president Greene has outlined what I consider to be the great problem confronting engineering educators in this country. President Burton has pointed out and emphasized very forcibly the character of some of the problems which confront us. I am delighted to have heard these words, as I know all of you are, from President Burton.

I will not attempt to outline any program of work for the coming year. I believe the President of your Society is not expected to do anything of the sort. What I may say is that I shall endeavor to carry on the good work of the Society, and that I feel I shall have your cordial support in all matters promoting engineering education.

If there is no further business to come before the society, I declare this convention adjourned.

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